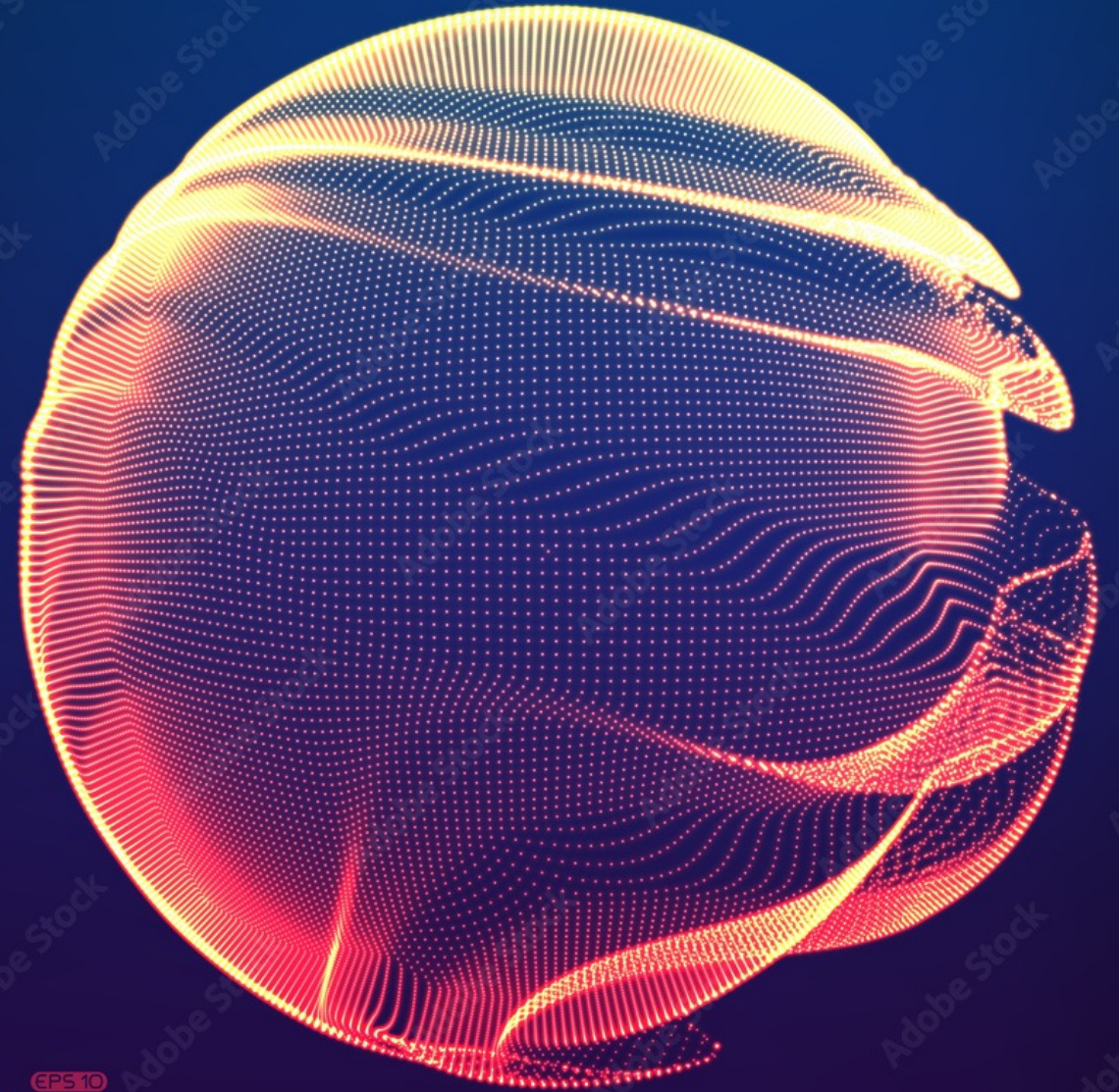


GLOBAL SCIENCE: TOOL OF NATIONAL CONTESTATION, NEO-COLONIAL HEGEMONY WRIT LARGE, THE HOPE OF THE WORLD, OR ALL OF THE ABOVE?

SIMON MARGINSON, UNIVERSITY OF OXFORD

BATH ICHEM, 20 JUNE 2023

1. Growth of global science
2. National and global science
3. Hegemony and exclusion
4. Change and conflict
5. Finally, is global science?



**I.
GROWTH OF
GLOBAL
SCIENCE**



THE GLOBAL SCIENCE SYSTEM

- *Growth:* Rising R&D spending in many countries and 5% growth in Scopus papers per year. Four fifths have university authors
- *Diversification:* Spread of national science capacity from Europe, Anglophone world and Japan to many more countries
- *Networked cooperation:* Rapid growth co-authored science via Internet, led initially from US
- *Global integration:* Growing role of global science system vis a vis national science systems



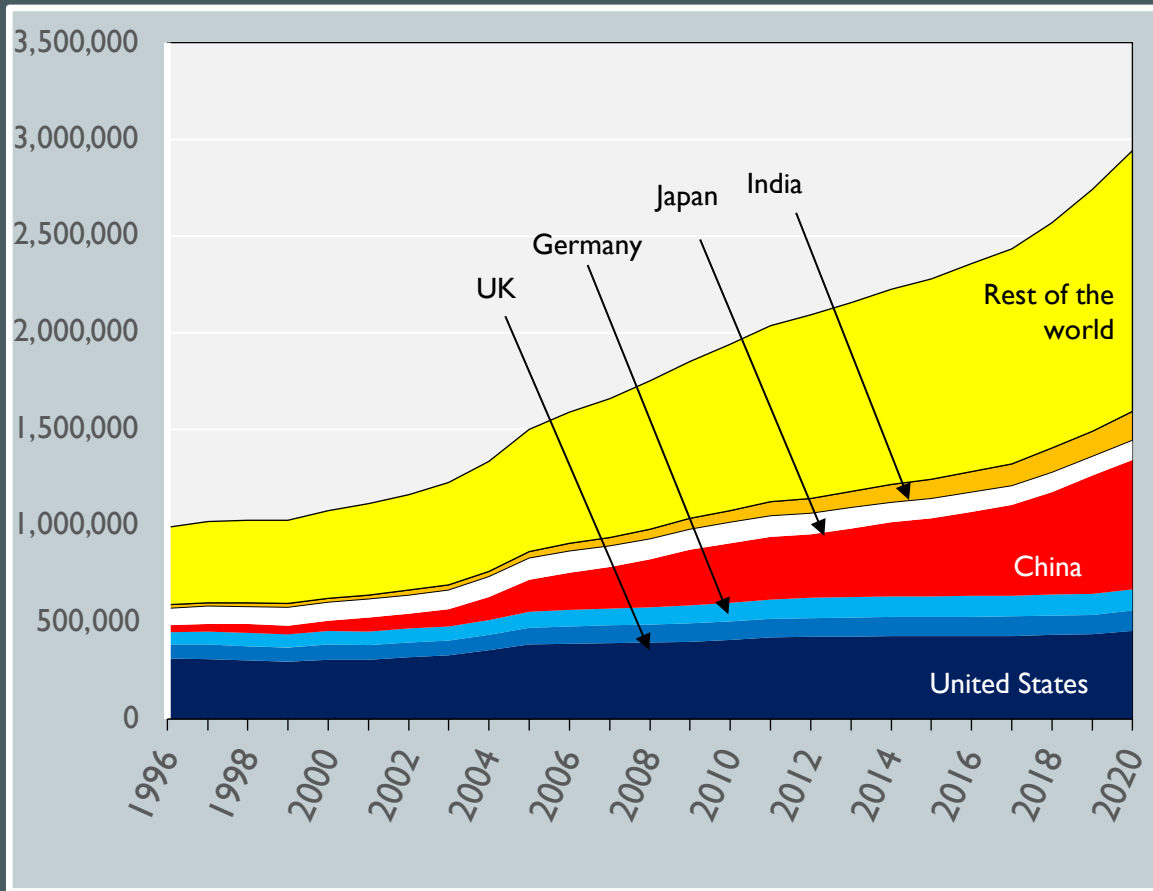
DYNAMICS OF OPEN NETWORKS

- Each new node expands the network at diminishing average cost per edge (link)
- “The organization may be more open to new members, since greater density of the network and the lowered in-betweenness measures suggest that fewer of the communications pass through the leading nodes or countries ... international cooperation is particularly advantageous for less advanced countries....With improved scanning of research and more effective communications, [researchers can] leverage foreign research, data, equipment, and know-how. ...The global network is arguably now a more stable system that serves as a source of vitality and direction to R&D at all lower levels...”

Wagner, C., Park H. and Leydesdorff, L. (2015). The continuing growth of global cooperation networks in research: A conundrum for national governments. *PLoS ONE* 10 (7): e0131816. doi:10.1371/journal.pone.0131816



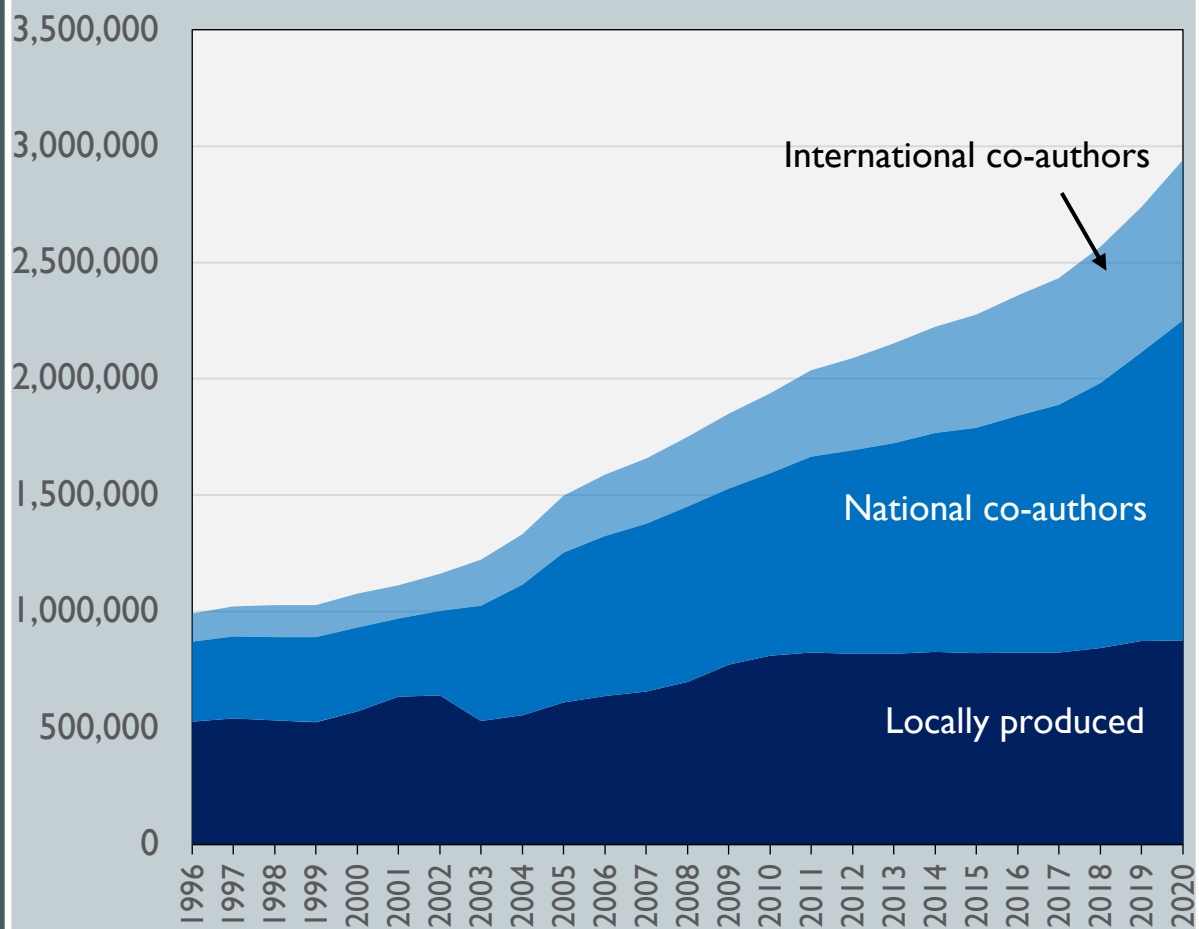
GROWTH OF SCIENCE PAPERS IN SCOPUS BY COUNTRY 1996-2020



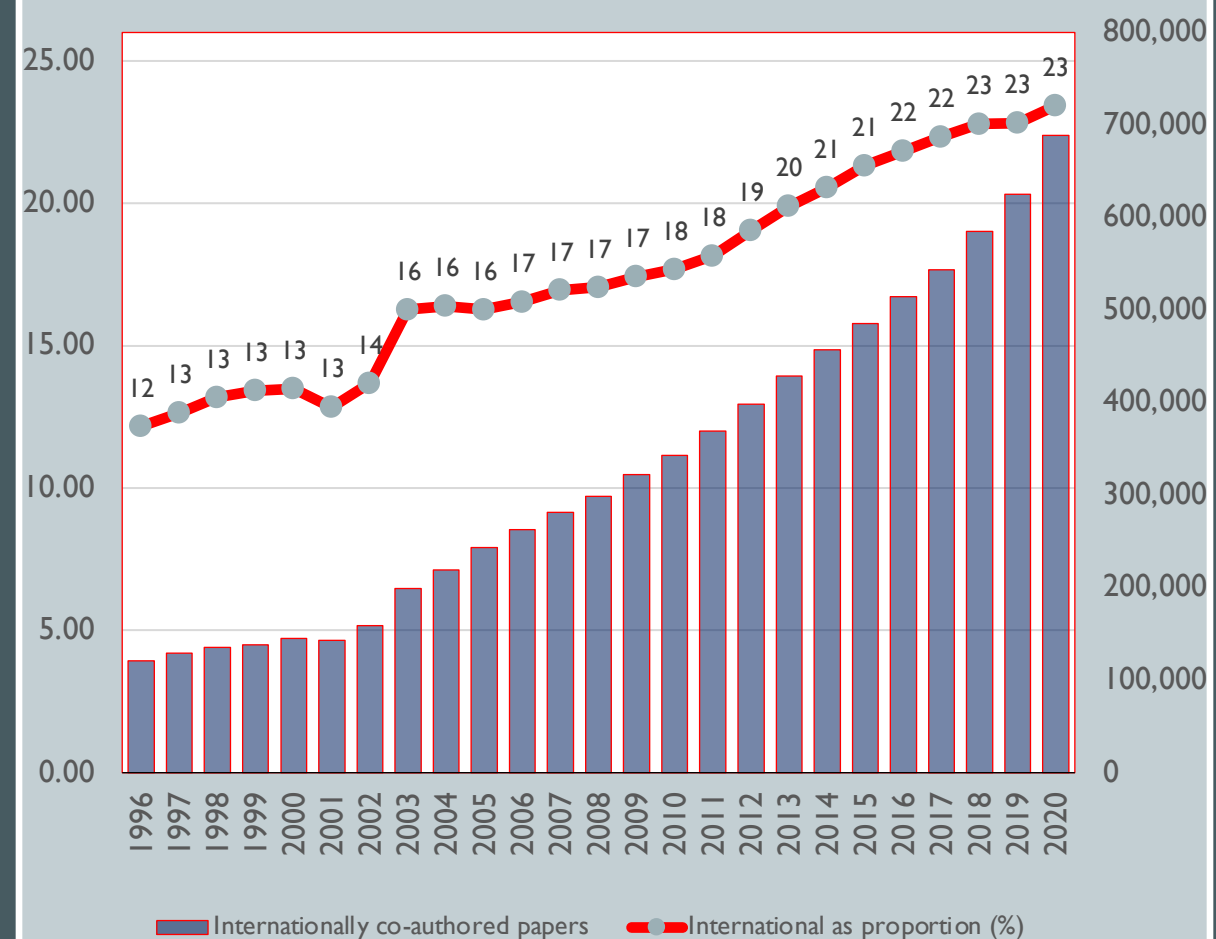
SPREAD OF RESEARCH TO MORE COUNTRIES 1987-2017

	1987 WoS	1997 Scopus	2007 Scopus	2017 Scopus
Producing 50% of world science	3 USA, UK, Germany	4 USA, Japan, Germany, UK	5 USA, China, Japan, Germany, UK	6 China, USA, India, Germany, Japan, UK
Producing 90% of world science	20 countries	23 countries	26 countries	32 countries

NUMBER OF SCIENCE PAPERS IN SCOPUS, BY TYPE OF COLLABORATION, WORLD: 1996-2020 — US NATIONAL SCIENCE BOARD



NUMBER AND PROPORTION (%) OF PAPERS INTERNATIONALLY CO-AUTHORED, WORLD: 1996-2020 — US NSB



INTERNATIONALLY MOBILE/ FOREIGN[*] DOCTORAL STUDENTS AS PROPORTION (%) ALL DOCTORAL STUDENTS, 2020 (FEMALE/ MALE)

Luxembourg	88/ 89%
Switzerland	56/ 58%
New Zealand	45/ 55%
Netherlands	45/ 51%
UK	40/ 42%
Austria	40/ 34%
France	38/ 38%
Denmark	33/ 40%
Iceland	33/ 54%
Ireland	32/ 39%
Belgium	32/ 33%
Sweden	31/ 40

Canada*	29/ 43%
Portugal	29/ 37%
Australia	28/ 39%
Japan	27/ 18%
Germany	23/ 23%
Hungary*	22/ 29%
OECD average	22/ 26%
Czech Republic	22/ 22%
Chile	22/ 17%
Finland	21/ 30%
Slovenia	20/ 20%
South Korea*	20/ 14%

Estonia	18/ 35%
Spain	18/ 20%
USA*	17/ 34%
Norway	16/ 28%
Slovak Republic*	8/ 15%
Israel	8/ 11%
Latvia	7/ 18%
Poland	7/ 9%
Turkey*	5/ 9%
Lithuania	4/ 10%
Brazil	2/ 3%
Colombia	2/ 2%

WHY RESEARCHERS COLLABORATE

- *Collegial and epistemic logics*: researchers follow pathways of inquiry, work with those with similar interests. Drive to the intellectual cutting edge
- *Shared culture and research programmes*: e.g. in Europe. Neighbouring countries. Same language e.g. co-authors in Spanish speaking systems. Friends
- *'Preferential attachment' (some of it exploitative)*: Cooperation for self-interest and status building, e.g. junior researchers secure benefits working with seniors, while senior researchers use junior researchers to do the 'grunt work'

US researchers connect everywhere, Europe connects to Europe, nodal role of China is growing, emerging countries often work with each other



THE SCIENCE NETWORK IS NOT A LEVEL PLAYING FIELD

”If hierarchy is neglected, preoccupation with connections may blur an accurate understanding ... the network is embedded in structural inequalities, but the impression arises that it operates in a vacuum.”

Sebastian Conrad (2016), *What is Global History?*, pp. 70, 127.



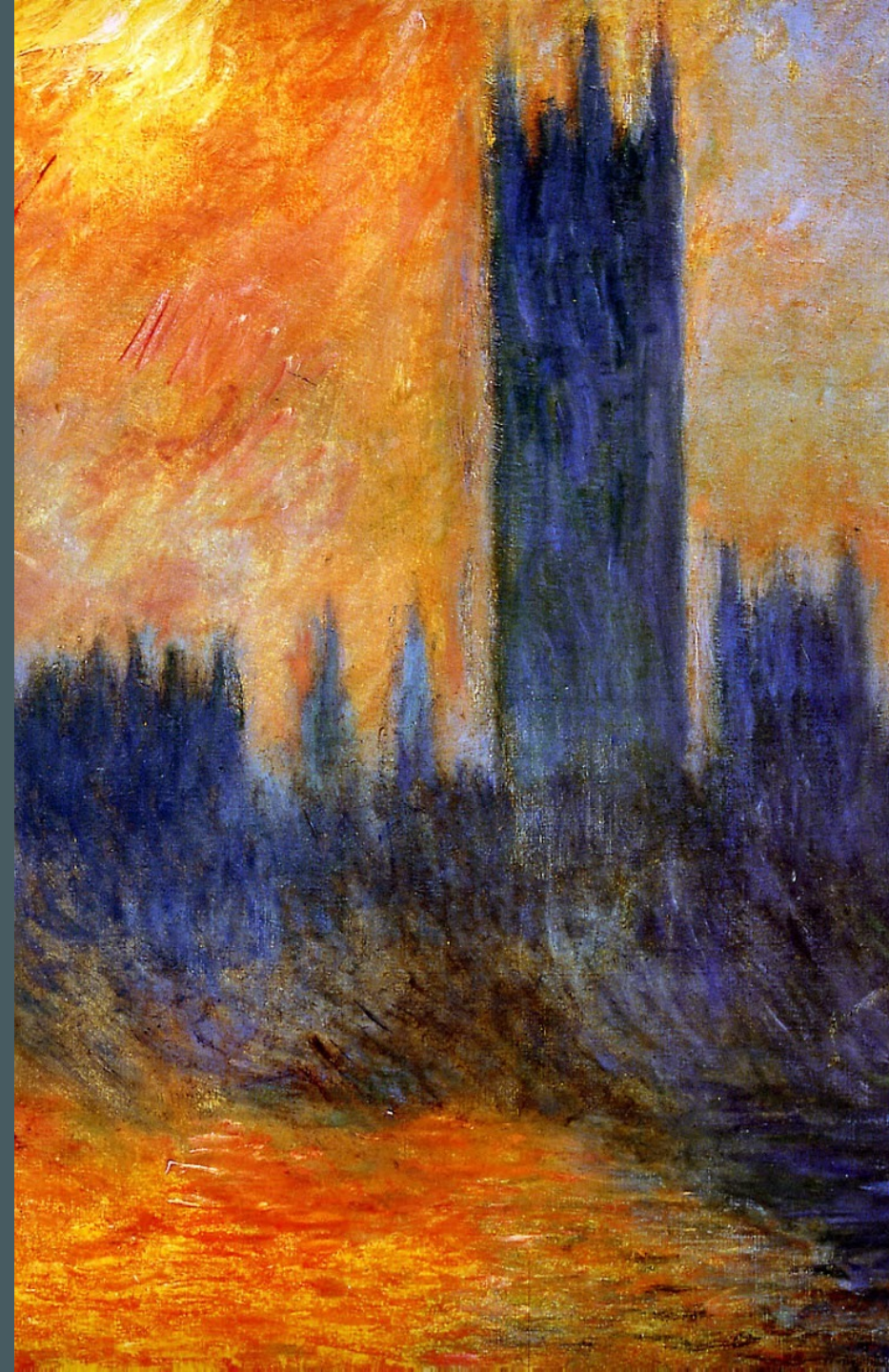
2.
**NATIONAL
AND
GLOBAL
SCIENCE**



“SCIENCES DEVELOP INTERNATIONALLY, BUT THE FUNDING IS MAINLY NATIONAL” (BORNMANN ET AL 2018)

Bornmann, L., Adams, J. and Leydesdorff, L. (2018). The negative effects of citing with a national orientation in terms of recognition: National and international citations in natural-sciences papers from Germany, the Netherlands, and the UK'. *Journal of Informetrics* 12 (3), 931–949.

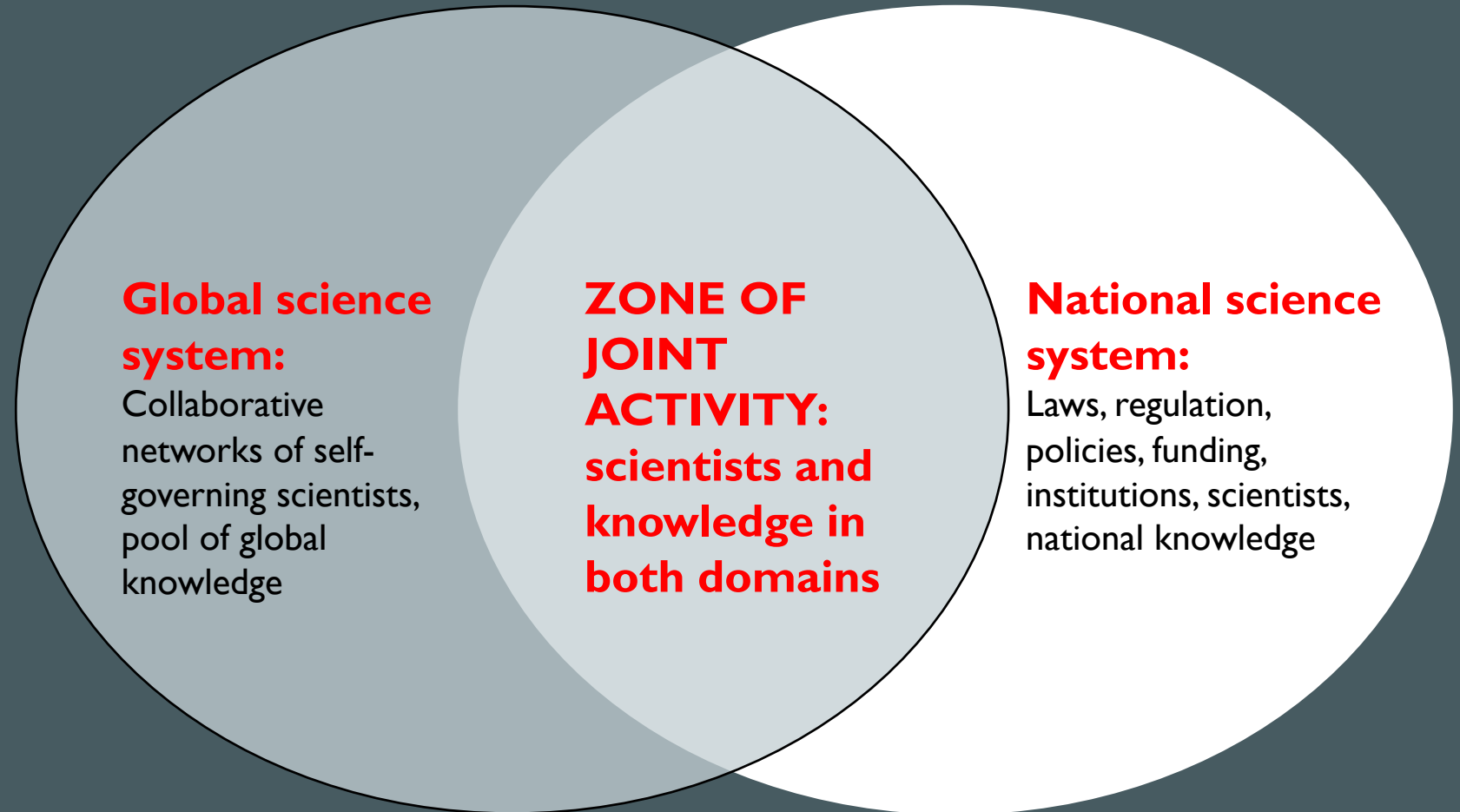
- Nations provide the legal, regulatory, policy, financial and institutional structure that supports nearly all science
- National investment in basic science has sustained the rapid growth. Nations encourage cross-border collaboration
- Yet nations do not drive the endogenous dynamics of science
- Nations normatively centre national science. But global science has no normative centre. “This dynamic system, operating orthogonally to national systems, is increasingly difficult to influence” (Wagner et al 2015).
- *But national security policy in S&T can retard global science*



SCIENCE IS *MULTI-SCALAR*: GLOBAL SCIENCE AND NATIONAL SCIENCE CONSTITUTE DISTINCT AND OVERLAPPING SYSTEMS

“The global network has a culture, pathways, and norms of communication specific to its structure, and diverging from national, regional, or disciplinary norms”

Wagner, Whetsell and Leydesdorff, 2017, p. 1646.



METHODOLOGICAL NATIONALISM BLOCKS A CLEAR VIEW OF SCIENCE

- Methodological nationalism is “the belief that the nation/state/society is the natural social and political form of the modern world” (Wimmer & Schiller 2003) and “the trajectory of nations is entirely determined by their own efforts” (Conrad 2016)
- “This ‘precludes a planetary consciousness, as we are stuck in global discourses underpinned by nation-state categories and identities’ (Shahjahan & Grimm 2022)
- “The only reality we are able to comprehensively describe statistically is national, or at best international” (Dale 2005)



GLOBAL SCIENCE IS SCIENCE
DRIVEN NOT POLICY DRIVEN
– AND NATIONAL RESEARCH
MOSTLY DOES NOT DRIVE
NATIONAL INNOVATION

Nations must connect to global science, but the
'knowledge economy' notion is a myth

- National science that enters the global pool is mostly used by foreign not local capital
- Innovations by nationally-based industry are mostly sourced in foreign science
- Most research is 'altruistic', not focused on national economic development (e.g. in medical and health sciences, social sciences)

Richard Klavans and Kevin Boyack (2017). The research focus of nations: Economic vs. altruistic motivations. PLOS ONE, 12 (1)



3.
**HEGEMONY
AND
EXCLUSION**



LEADING RESEARCH UNIVERSITIES IN GLOBAL SCIENCE

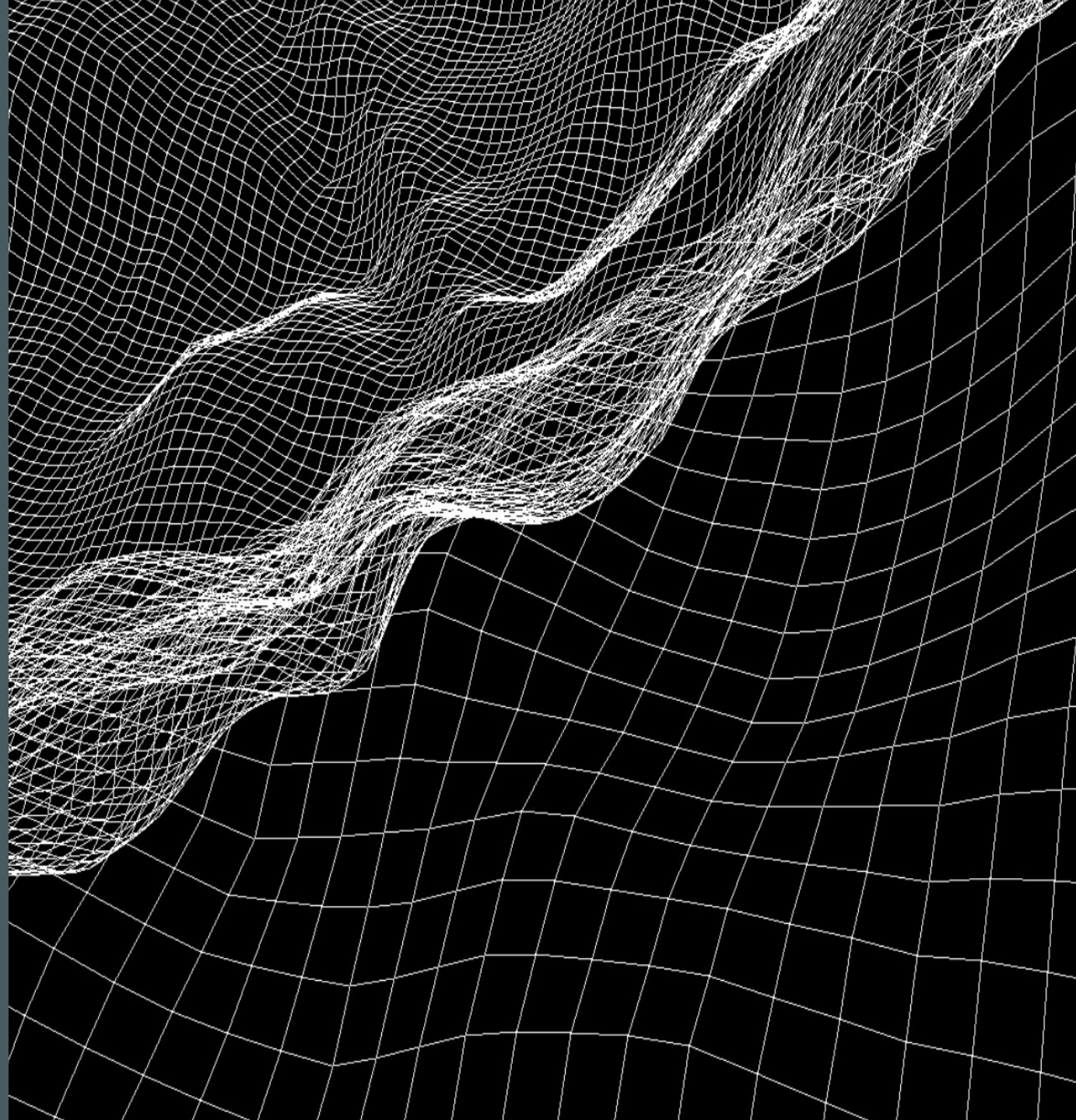
(Leiden ranking, universities with most top 5% papers by citation rate, 2017-2020, original data Web of Science)

university	country	top 5% papers	all papers	% of papers in top 5%	cross-border papers	% of papers cross-border
Harvard U	USA	4276	35,050	12.2%	44,930	54.4%
Stanford U	USA	2140	17,187	12.5%	20,174	47.6%
U Toronto	CANADA	1773	24,260	7.3%	29,586	59.1%
Tsinghua U	CHINA	1726	22,311	7.7%	16,668	37.7%
U Oxford	UK	1722	16,499	10.4%	30,755	71.1%
Zhejiang U	CHINA	1640	29,091	5.6%	15,727	31.8%
U Michigan	USA	1508	19,609	7.7%	17,999	41.2%
MIT	USA	1501	10,503	14.3%	17,621	58.8%
U College London	UK	1446	15,560	9.3%	29,131	68.2%
U Cambridge	UK	1425	14,268	10.0%	26,130	71.6%
Shanghai Jiao Tong U	CHINA	1405	28,703	4.9%	16,014	31.4%
Johns Hopkins U	USA	1404	17,708	7.9%	21,048	47.0%
Huazhong U S&T	CHINA	1311	21,654	6.1%	9,823	28.0%
U Pennsylvania	USA	1290	14,100	9.1%	13,628	38.9%
U Washington, Seattle	USA	1267	14,847	8.5%	17,542	44.5%
Columbia U	USA	1249	12,891	9.7%	17,092	49.5%



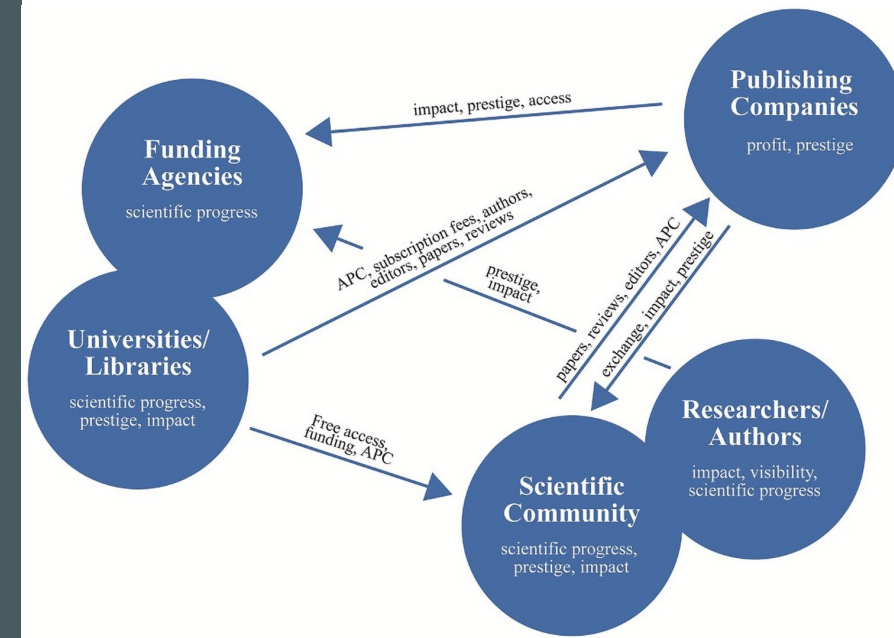
GLOBAL SCIENCE IS REAL BUT ITS BOUNDARY IS CONSTRUCTED

- Top global science universities concentrate resources, talent, outputs. They excel in a competition they themselves define
- Global science derives from selected English language outputs in disciplines led (research, editing) from these universities. Knowledge included as global science is shaped in the interactions of top scientists, publishers, and the two bibliometric data bases (Web of Science and Scopus)
- There is a double stratification of value of knowledge: (1) inclusion/ exclusion binary, (2) hierarchy within global science
- *Most human knowledge is excluded*






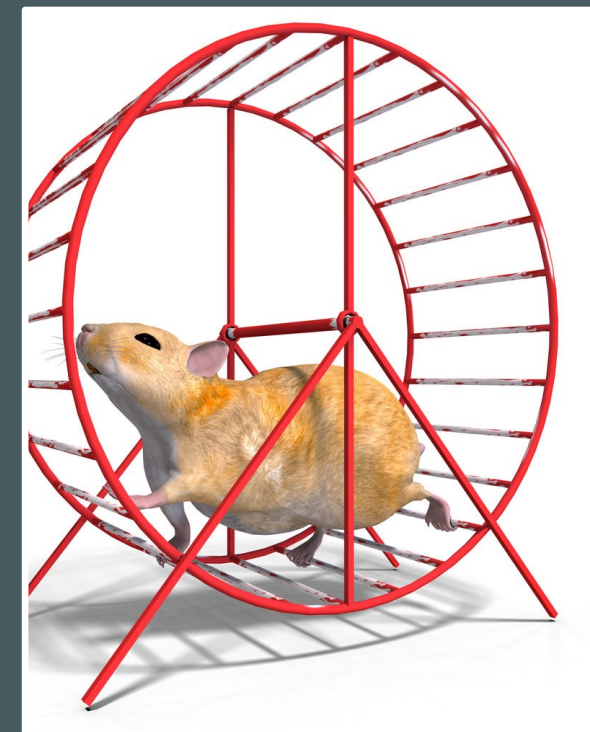
'GLOBAL SCIENCE' IS KNOWLEDGE PUBLISHED BY FIVE FIRMS, LEGITIMATED AND VALUE-ORDERED BY BIBLIOMETRICS

- Most broadly recognised 'science' (some social science) is published by Elsevier, SpringerNature, Taylor and Francis, Wiley-Blackwell and Sage - capitalist firms driven by profit and market share, that absorb academic networks, grow and diversify journals and users, own and monetarise output, create scarcity and differentiate value, shape and speed up academic life
- Published science is selected into two bibliometric collections, Elsevier/ Scopus and Clarivate Analytics/ Web of Science. Their citation data calibrate the value of journals and papers, creating a quasi-economy of science based on differentiated values, that determines university hierarchies, research funding, and the valuation, appointment and promotion of individuals
- Bibliometric data are foundational to global university rankings



BIBLIOMETRICS IN GLOBAL RANKINGS STRATIFY WORLDWIDE HIGHER EDUCATION

Rankings	Publication-related indicators as proportion %	Databases
Shanghai Jiaotong Academic Rankings of World Universities (China) 	70.0	Clarivate Analytics' Web of Science
Times Higher Education World University Rankings (UK) 	38.5*	Elsevier's Scopus
QS World University Rankings (UK) 	20.0*	Elsevier's Scopus
Leiden Ranking (Netherlands)	100.0	Clarivate Analytics' Web of Science
Best Global Universities (US)	72.5	Clarivate Analytics' Web of Science



Source: The methodology pages on above rankings' websites, updated on 21-January-2021.

* Research performance has a further, indirect but important, effect through its impact on the surveys used by THE and QS, and in THE data on postgraduate studies and income – in total research is more than two thirds of the THE index

GLOBAL SCIENCE AS HEGEMONIC SOCIAL PRACTICE

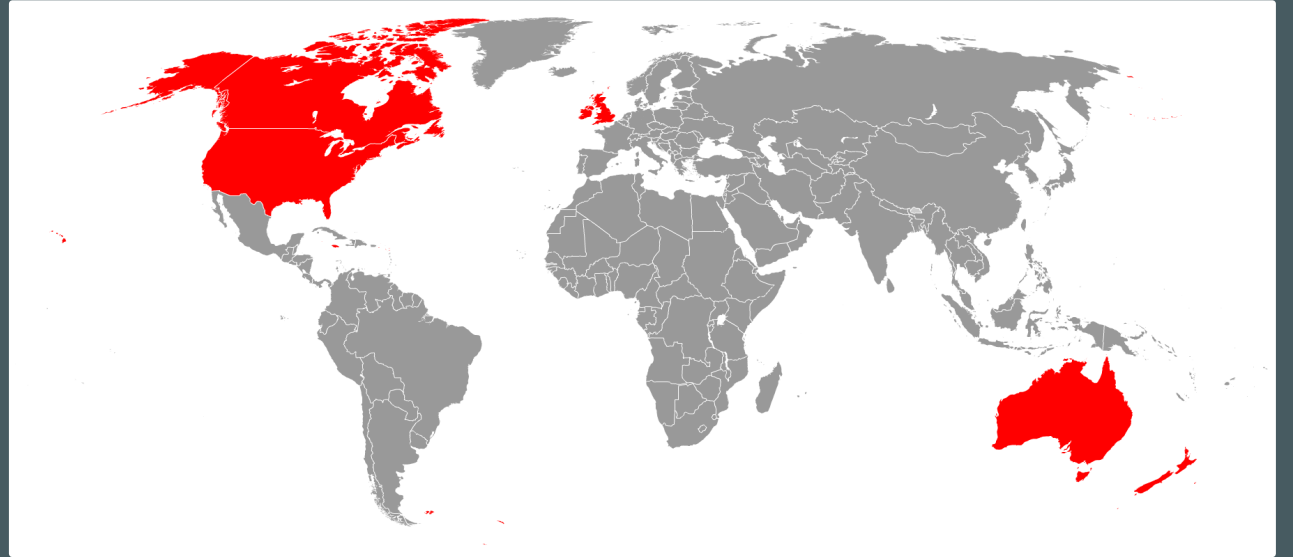
Q. In the selection and reproduction of global science, which knowledge and which knowledge agents are *excluded*?

A. Everything and everyone else



WHAT IS *EXCLUDED* FROM GLOBAL SCIENCE?

- ‘Grey literature’, institutional research, policy papers not in the public domain
- National and local science that does not enter the global journals
- Much medical research, more of social science, most humanities, most books
- Almost all knowledge in languages other than English
- Indigenous knowledge, in continuity with colonial epistemic exclusion
- *These exclusions are the work of scientists, not just publishers or nation-states*



Countries where English is the LI of more than half the population

English is the first language (LI) of 373 million (4.7%) of the world's population and the second language of 13.5%.

Other LI with over 100 million speakers are Mandarin Chinese 11.6%, Spanish 5.9%, Hindi 4.3%, Bengali 2.9%, Portuguese 2.9%, Russian 1.9%, Japanese 1.6%

But 98% of papers in Web of Science and 96% in Scopus are in English. These papers acquire the status of ‘universal knowledge’... other knowledge is treated as ‘local’

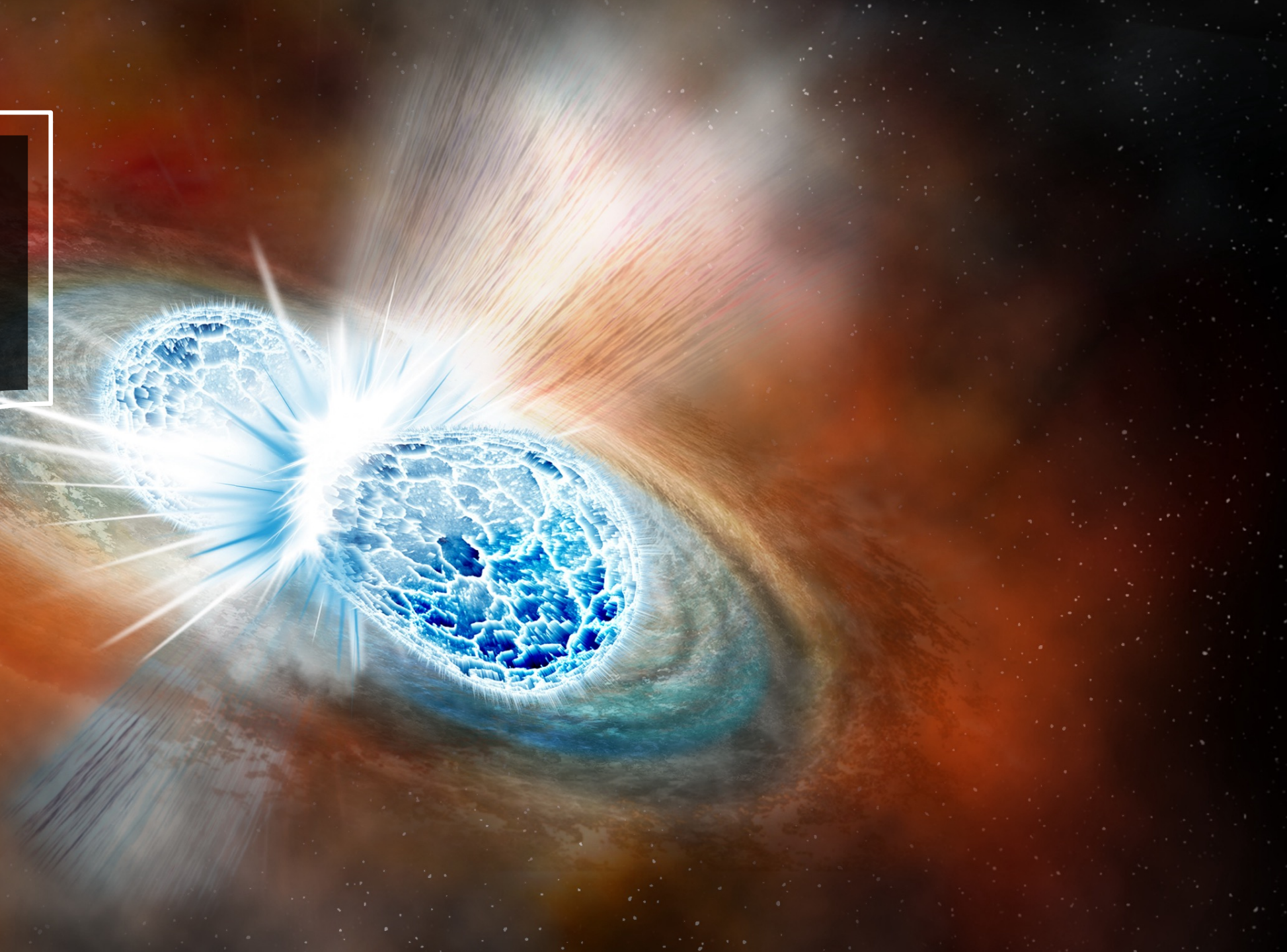
THE 'ABYSS' BETWEEN THE DOMINANT CULTURE AND THE EXCLUDED OTHERS

“... the understanding of the world by far exceeds the Western understanding of the world and therefore our knowledge of globalization is much less global than globalization itself... the more non-Western understandings of the world are identified, the more evident it becomes that there are still many others to be identified and hybrid understandings, mixing Western and non-Western components, are virtually infinite.

“Post-abyssal thinking thus stems from the idea that the diversity of the world is inexhaustible and that such diversity still lacks an adequate epistemology. In other words, the epistemological diversity of the world does not yet have a form. ... Post-abyssal thinking confronts the monoculture of modern science with the ecology of knowledges”



**4.
SIGNS OF
CHANGE**



PUSHBACK IN LATIN AMERICA

- “The mainstream has been self built on the supposition that outside there is backwardness and lack of academic value”
- “The publishing system has become determinant in the distribution of scientific recognition by reinforcing a hierarchy built on the basis of a triple principle: institutional development, discipline and proficiency in English”

Beigel, F. (2014). Introduction: Current tensions and trends in the World Scientific System. *Current Sociology*, 62(5), 617–625

- “Visibility alone is not enough. Effective presence requires being in such a state of visibility that anyone neglecting it will be faulted for carelessness, incompetence or ignorance. ... While much good and even extraordinary science does exist in non-OECD countries, it needs to be integrated at its right place within (real) world science”

Vessuri, H., Guédon, J. C., & Cetto, A. M. (2014). Excellence or quality? Impact of the current competition regime on science and scientific publishing in Latin America and its implications for development. *Current Sociology*, 62(5), 647–665



IN THE LAST TWO DECADES SCIENCE CAPACITY HAS DEVELOPED RAPIDLY IN MIDDLE INCOME AND SOME LOWER INCOME COUNTRIES

- Global capacity in higher education and science is becoming more distributed, diverse
- Science is no longer the monopoly of Europe, the Anglophone nations, Japan
- China, India, Iran, South Korea, Brazil, Turkey, Singapore are increasingly important
- However, the cultural content is still neo-imperial – English language and the Euro-American disciplines. Resources matter, and over time the cultural content will diversify

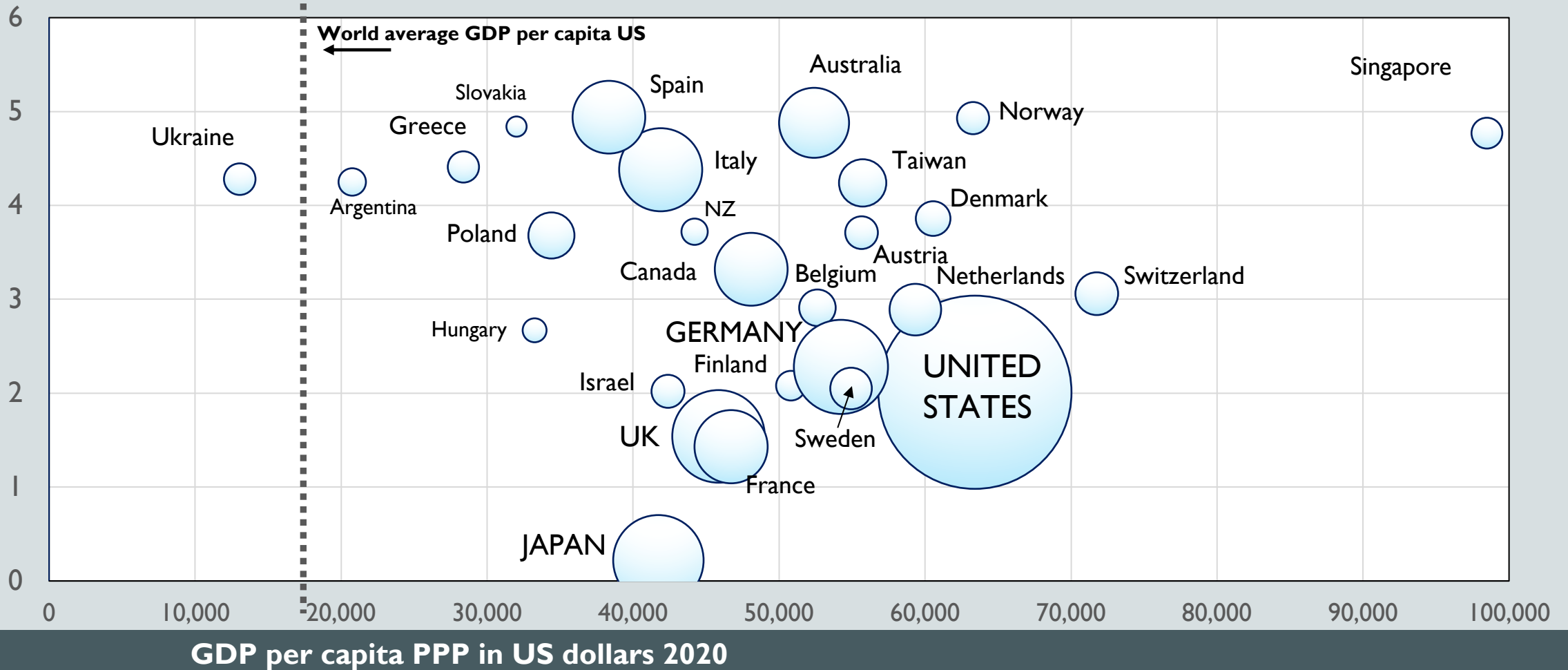


ESTABLISHED AND SLOW GROWING SCIENCE SYSTEMS 2000-2020

NATIONAL OUTPUT OF SCIENCE PAPERS GREW SLOWER THAN THE WORLD AVERAGE RATE OF 5.15% PER YEAR BETWEEN 2000 AND 2020 - COMPARED TO WORLD AVERAGE GDP PER CAPITA PPP (US \$17,083 IN 2020)

Science systems with 5,000 papers or more in 2020. Scopus data, fractional counting (NSF 2021). Current price GDP, PPP = purchasing power parity (World Bank 2022).

Growth
p.a.(%)
science
papers

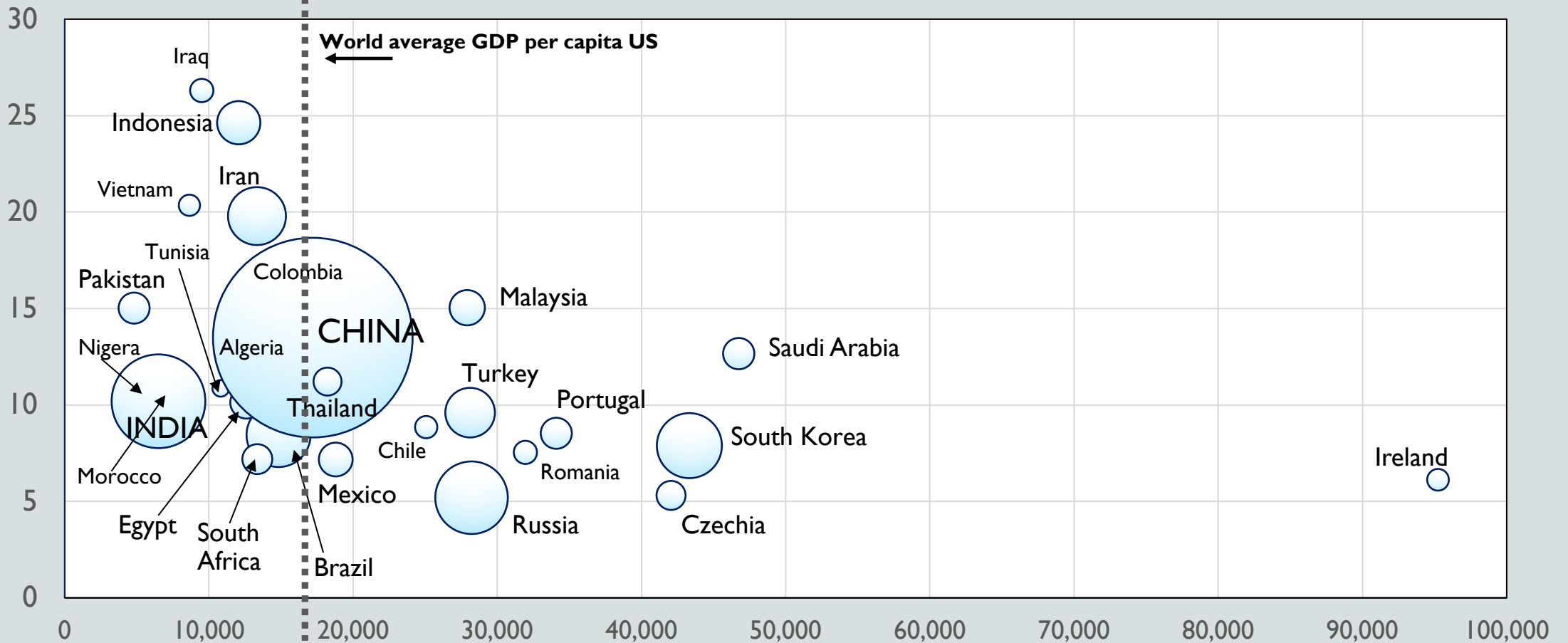


EMERGING AND FAST GROWING SCIENCE SYSTEMS 2000-2020

NATIONAL OUTPUT OF SCIENCE PAPERS GREW FASTER THAN THE WORLD AVERAGE RATE OF 5.15% PER YEAR BETWEEN 2000 AND 2020 - COMPARED TO WORLD AVERAGE GDP PER CAPITA PPP (US \$17,083 IN 2020)

Science systems with 5,000 papers or more in 2020. Scopus data, fractional counting (NSF 2021). Current price GDP, PPP = purchasing power parity (World Bank 2022).

Growth
p.a.(%)
science
papers



GDP per capita PPP in US dollars 2020

TOP UNIVERSITIES IN STEM RESEARCH, LEIDEN RANKING

PAPERS IN TOP 5% BY CITATION RATE, 2017-2020, IN (1) PHYSICAL SCIENCES & ENGINEERING, (2) MATHEMATICS & COMPUTING:

University	System	(1) Physical sciences & Engineering
Tsinghua U	CHINA	988
Zhejiang U	CHINA	670
MIT	USA	633
U Science & Technol	CHINA	619
Shanghai JT U	CHINA	601
Huazhong U S&T	CHINA	600
Harbin IT	CHINA	578
Nanyang TU	SINGAPORE	567
Xi'an Jiaotong U	CHINA	562
Hunan U	CHINA	536
Stanford U	USA	529
U Chinese Acad Sci	CHINA	526
Tianjan U	CHINA	523
National U Singapore	SINGAPORE	512

University	System	(2) Mathematics & Computing
U Electron S&T	CHINA	360
Tsinghua U	CHINA	342
Harbin IT	CHINA	283
Huazhong U S&T	CHINA	253
Xidian U	CHINA	232
Beihang U	CHINA	221
Southeastern U	CHINA	216
Nanyang TU	SINGAPORE	205
Zhejiang U	CHINA	204
Northwestern P. U	CHINA	197
Shanghai Jiao Tong U	CHINA	196
Wuhan U	CHINA	193
MIT	USA	177
Xi'an Jiaotong U	CHINA	174

TOP UNIVERSITIES IN OTHER SCIENCE FIELDS

PAPERS IN TOP 5% BY CITATION RATE, 2017-2020, IN (1) BIOMEDICINE & HEALTH SCIENCES (2) LIFE & EARTH SCIENCES

University	System	(1) Biomedicine & Health Sciences
Harvard U	USA	3019
U Toronto	CANADA	1130
Johns Hopkins U	USA	1068
Stanford U	USA	1028
U Calif San Francisco	USA	947
U Pennsylvania	USA	860
U College London	UK	825
U Oxford	UK	800
U Michigan	USA	795
U Texas HSC Houston	USA	727
U Washington Seattle	USA	690
Yale U	USA	686
Columbia U	USA	677
U Calif San Diego	USA	651

University	System	(2) Life & Earth Sciences
Zhejiang U	CHINA	281
Wageningen U	NETHERLANDS	268
China Agriculture U	CHINA	248
Harvard U	USA	240
ETH Zurich	SWITZERLAND	239
U Calif Davis	USA	235
Cornell U	USA	220
U Oxford	UK	215
China U Geoscience	CHINA	214
U Chinese Acad Sci	CHINA	213
U Florida	USA	213
U Queensland	AUSTRALIA	201
Tsinghua U	CHINA	200
U Calif Berkeley	USA	200

GROWING IMPACT OF GEO-POLITICS

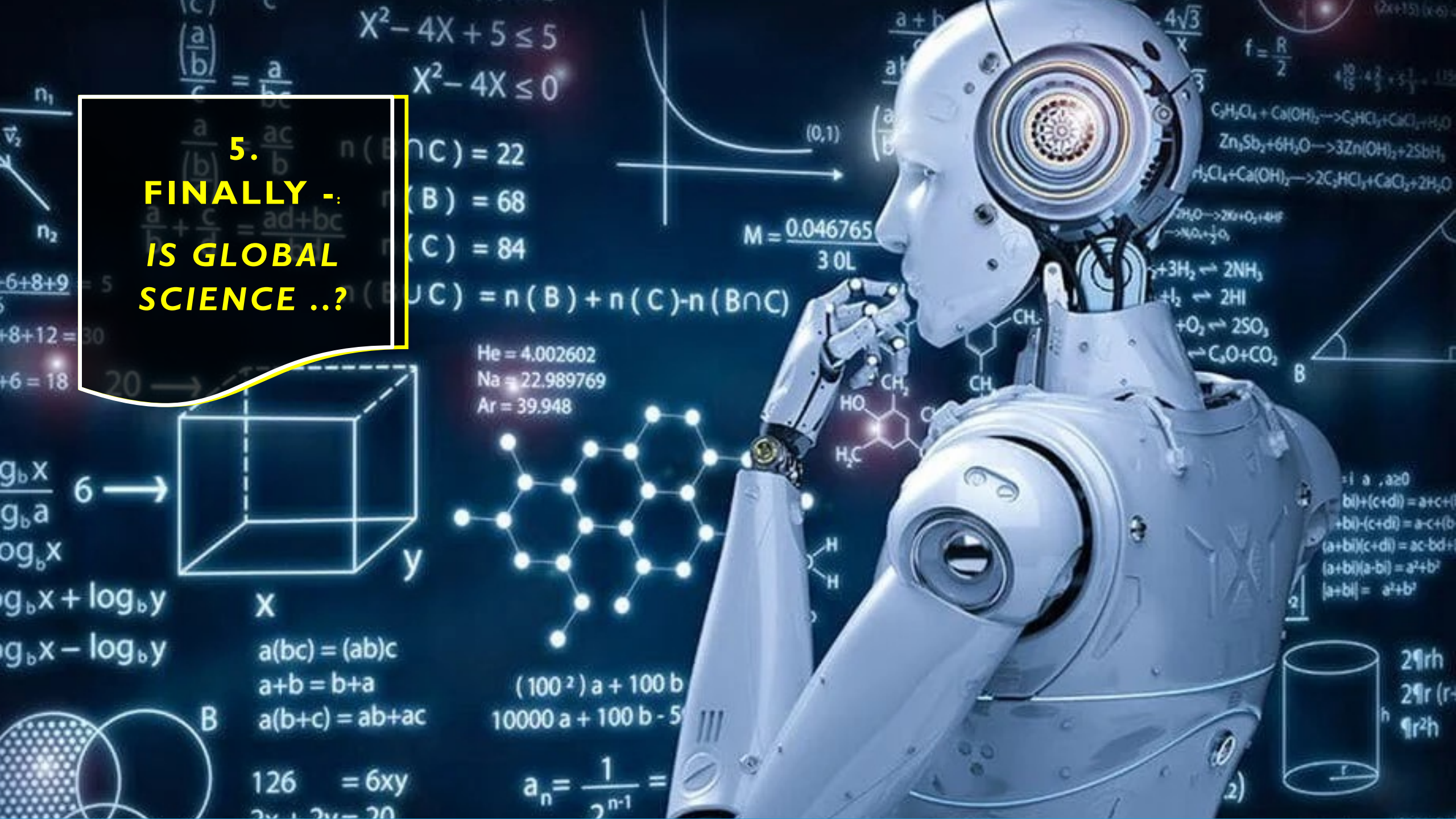
- National ‘securitisation’ in science takes priority over collaboration, university autonomy, academic freedom
- US-China decoupling in science and technology as part of US strategy to maintain global dominance. Long-term future of integrated global science system in doubt
- Nativist politics: pushback against ‘globalism’ and in some countries, against international students
- Brexit takes UK out of Horizon research programmes, weakens academic cooperation and mobility
- Ukraine universities decimated. Russia closes up internally and breaks with international university networks, weakening and isolation of Russian science



“Scientific discovery, fundamentally borderless, is being politically bordered. Geopolitical tensions between the US and China have spilled over into academic science, creating challenges for many scientists’ ability to fully engage in research and innovation”

Jenny Lee and Xiaojie Li, *Racial profiling among scientists of Chinese descent*, 2022

5.
**FINALLY -
IS GLOBAL
SCIENCE ..?**



$$X^2 - 4X + 5 \leq 5$$

$$X^2 - 4X \leq 0$$



$$M = \frac{0.046765}{3.0L}$$

He = 4.002602
Na = 22.989769
Ar = 39.948



$$(100^2)a + 100b$$
$$10000a + 100b - 5$$

$$a_n = \frac{1}{2^{n-1}}$$

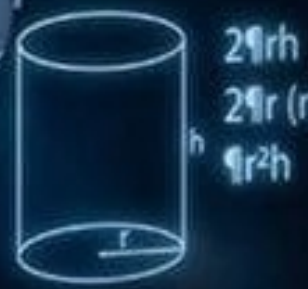


X

$$a(bc) = (ab)c$$
$$a+b = b+a$$
$$a(b+c) = ab+ac$$

B

$$126 = 6xy$$
$$2x + 2y = 20$$

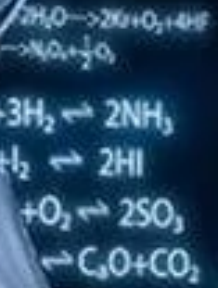
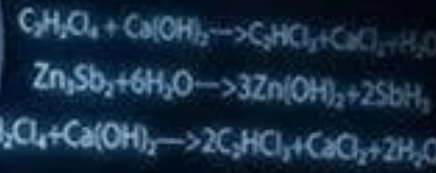


$$|a+b| = a^2+b^2$$
$$|a-b| = a^2-b^2$$
$$(a+b)(c+d) = ac+bd+(a+b)(c+d) = ac+bd+(a+b)(c+d)$$
$$(a+b)(c+d) = ac+bd+(a+b)(c+d)$$
$$(a+b)(c+d) = ac+bd+(a+b)(c+d)$$

$$\frac{g_b x}{g_b a}$$
$$\log_b x$$
$$\log_b x + \log_b y$$
$$\log_b x - \log_b y$$



$$n_1$$
$$n_2$$
$$-6+8+9 = 5$$
$$+8+12 = 30$$
$$+6 = 18$$
$$20 \rightarrow$$



A TOOL OF
NATIONAL
CONTESTATION?



A NEO-
COLONIAL
MONSTER?



THE HOPE OF
THE WORLD?



ALL OF THE
ABOVE?



GLOBAL SCIENCE: UPSIDES AND DOWNSIDES

- Fast growing, spreading across the world
- Collective, collaborative and accumulative, open and with increasingly diverse voices
- Knowledge that is vital to everyone's future! A common good that crosses over separate self-interests of individuals/groups
- Looks beyond a nation-bound perspective and 'thinks through the world'
- Uses concepts and methods that are widely shared and understood
- Can talk truth to power
- *BUT* it is culturally fixed, too exclusively Western, neo-colonial, steeply hierarchical




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

- We must break the hold of the commercial publishers on knowledge - no cost open access to all university research!
- Stop the blocking of cooperation with researchers in China, lift the barriers to mobility and knowledge sharing
- Foster an 'ecology of knowledges' (Santos 2006) including indigenous knowledges, grounded in listening to the other, e.g. widespread translation of works in other languages into the common global language, multi-lingual journal papers



A young woman with brown hair, wearing a black and white patterned sleeveless top, is speaking into a black megaphone. The megaphone has a green logo on it that says "FUTURE IS NOW" and features a triangle with a circle inside. She is surrounded by a large crowd of people, many of whom are holding up their smartphones to take photos or videos. The background is slightly blurred, showing more people and some greenery.

**YES, "LISTEN
TO THE
SCIENCE"
BUT WHICH
SCIENCE?
TIME WILL
TELL!**