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Moving beyond centre-periphery science: Towards an ecology of knowledge

Simon Marginson & Xin Xu

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Simon Marginson & Xin Xu

Simon Marginson is Professor of Higher Education in the Department of Education at the University of Oxford, Director of the ESRC/OFSRE Centre for Global Higher Education, and Joint Editor-in-Chief of *Higher Education*.
simon.marginson@education.ox.ac.uk
ORCID ID: https://orcid.org/0000-0002-6738-3128

Xin Xu is Research Fellow in the ESRC/OFSRE Centre for Global Higher Education, Department of Education, University of Oxford. xin.xu@education.ox.ac.uk
ORCID ID: https://orcid.org/0000-0002-9972-8995

Abstract

The evolution of a large and dynamic global system of science has been a major development of the Internet era. The networked system, grounded in autonomous collegial activity, is associated with rapid growth in papers, the spread of science infrastructure to a growing number of countries, and the rise of new science powers outside Euro-America. The United States remains the strongest country in shaping authoritative knowledge but China excels in total papers and in some STEM disciplines. Yet despite the fact of a more multi-polar world, in economic capacity, political agency and scientific output, there is continued Euro-American domination in the content of science, regulated by an inside/outside binary which reproduces the old North/South and West/East hierarchies. Global science is unequalising and homogenising, and primarily Anglo-American in language, leading institutions, disciplinary and publishing regimes, agendas and topics. Non-English language work

and endogenous knowledges are excluded. Scholarship on global science does not effectively address these issues. The fascination with bibliometrics merely reproduces the inside/outside binary: all of those conducting scientometric research and the university rankings based on bibliometric data are complicit in the fiction that the knowledge stored in the commercial repositories of Web of Science and Scopus is all that needs to be known. Not all of the critical work on global science has been helpful either. The paper critiques the dominant imaginary of world science, world-systems theory with its centre-periphery model. This theory fails to grasp the dynamics of the specifically global system, and radically under-estimates agency outside the 'centre' countries, as shown by the manner in which nation-states and autonomous researchers on the 'semi-periphery' and 'periphery' have been able to rapidly develop science. The centre-periphery model is unduly determinist, in the outcome reinforcing the Eurocentrism it opposes. The paper argues for a critique of hegemony not centre-periphery, focusing on cultural factors as well as political economy, and for an 'ecology of knowledges' approach as the way forward.

Keywords: Science, Research, Universities, Global cooperation, Globalisation, Hegemony, Development, World-systems theory, Centre-periphery, English language

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Introduction

In the last three decades, basic science centred on universities and research institutes across the world has been transformed, in some but not in all respects. It has become larger, more global and much more networked, and more distributed and diverse. Yet it has grown little in language and agenda making. It remains monocultural in form and contents.

After World War II science evolved within nationally normed and funded systems. On the world scale it developed as an uneven Euro-American duopoly. The United States (US), which was dominant, linked to Western Europe with Japan as a later outlier. Soviet Russia was fenced off behind the Cold War barrier. Science was Eurocentric (the term refers to the European civilisational bloc, including North America) in its assumptions and mechanisms, and within that, primarily Anglo-American. The geo-politics of science has now partly shifted towards multipolarity, with the emergence of large robust national science systems outside the Euro-American duopoly and the rapid growth of papers in emerging country science systems. This development is congruent with the evolution of a more multipolar world political economy (Pieterse 2018); and since the 1990s has been facilitated by the Internet, which sustains conditions for synchronous community in science on a global scale, accelerating connectivity in science on the basis of the logic of network growth. In a network each successive node is added at negligible cost and adds value to the existing nodes by augmenting connections. Hence electronically mediated collaborative science grows more rapidly than linear forms, extending towards every possible connection while also intensifying relations between the existing nodes (Castells 2000). Wagner et al. (2015) describe networked global science as a ‘dynamic’ open communication system, autonomous, evolving endogenously, an ‘emerging organisation’ in its own right (11-12).

Along with the growing multi-polarity, the great change in science is the emergence of the discrete global communications system, consisting of publishing and collaboration, autonomous, grounded in collegial interactions between scientists.

Arguably the collegial global system has catalysed the more rapid growth of scientific activity across the world, sustained by growing national investments (OECD 2020), as governments have sought to access the common pool of knowledge now instantly accessible (Royal Society 2011).

However, the foundational assumptions and culture of the global science network have changed less than its membership. As Conrad (2016) remarks, networks do not operate in a vacuum. They are 'embedded in structural inequalities', and hierarchies also play a key role inside networks (127), though stratification is often under-estimated in network analysis. The operations of the collegial global system of science continue to be highly stratified, with a hierarchy of value in some respects little altered since its origins in the 1990s. The normative leadership of US science has been grounded in its large federal research programmes, strong universities, infrastructure and concentration of talent, including immigrant talent (Kerr 2001). US scientists were at the early forefront of the Internet, which initially was English language dominated (Castells 2000); and the early global system was patterned by American norms of both academic freedom and social order, including value hierarchies. Arguably, global science remains structured by a Euro-American (and mostly Anglo-American) inclusion/exclusion binary that operates at two levels: first, in the determination of what is included in the global system; and second, in the ordering of value inside it (Santos 2007). This structure is grounded in history, resource inequality, institutions, and language, cultural homogeneity and agendas. There is a lack of fit between more globally distributed agency in terms of political economy and scientific output, and the continuing global centralisation of intellect and imagination.

This paper is focused on understandings of global and national science, the drivers of inequality and suppression of diversity, and the potential for agency and change. In particular, it critically reviews the dominant explanation of relations of power in global science, derived from world systems theory and its notion of a fixed centre-periphery hierarchy of nations bolted down by political economy (Wallerstein 1974; Wallerstein et al. 2013), in which global science is understood as a centre-periphery hierarchy, a developed version of the North-South binary also in widespread use.

The paper argues that the centre-periphery model is an obstacle to diagnosing science. It has failed the test of history: it cannot explain the rapid growth and diversification of science, nor the autonomy of the global system distinct from nations. By arguing that science is zero-sum and determined by a fixed division of labour in a singular world system, it underestimates the potential of the agency of states and scientists in emerging countries. It also neglects institutions, language and cultural factors in sustaining Eurocentrism. The paper argues for a different theorisation of relations of power in science, based on hegemony rather than a centre-periphery model.

The paper is partly grounded in a larger study of globalisation and knowledge (Marginson forthcoming). That study draws on secondary data bases (NSB 2020; Leiden University 2020) from the main bibliometric collections, Scopus/Elsevier and Web of Science/Clarivate Analytics (Waltman 2016), and a review of 200 papers in science policy and scientometrics from 2018-2020, plus earlier works. The next section briefly summarises the dual systems of global and national science, and growth and diversification in science. The following section expands on global inequality and monoculture. Then the paper moves to the centre-periphery model, outlining world systems theory and its applications in the scholarship of science, and problems of the theory. The final section argues for diversity in science grounded in an ecology of knowledges as a way to unlock the present hegemony.

Global and national science

Science in each country now consists of two distinctive and coupled systems, orthogonal to each other, heterogeneous: the global science system and national science systems.

By ‘global’ is meant activities and relations that constitute a planetary ontology and tend to the evolution of the world on an integrated basis (Marginson et al. 2010; Conrad 2016). ‘National’ is bordered by the fiat of territorial states. A national science system is structured by laws, policies, resources and institutions. It fosters collaborative activities, some nationally bordered and some that reach into the world,

while also seeking to advance the prosperity and security of the nation. In material terms national science is essential to global scientific collaboration and output; while at the same time, as outlined, the growth of global science drives expanding national investments in university research: there is a symbiosis between the growth of global science and of national capacity (Marginson 2018). But nationally normed science systems do not control or contain global science. Global science has no single normative agent. It is regulated by the emerging interactions of academic communities and professional scientists. Scientists bring to bear on their work individual and collective goals, cognitive cultures, knowledge, imagination, associations, beliefs and habits. Studies of science (e.g. Georghiou 1998; Winkler et al. 2015; Chen et al. 2019) discuss the motivators of collaboration, including cognitive accumulation, drive to the cutting edge, friendship, proximity, cultural affinity, shared values, and preferential attachment, the potential for status and career benefits. Scientists are not necessarily bound by their affiliation or nationality; they mobilise across countries and move freely between disciplinary global science and national/institutional systems. Often the disciplinary loyalties are stronger (Adams 2013; Wagner et al. 2015).

This dual structure, global and national science, is associated with rapid growth, and diversification by country of origin, in the codified science in Scopus and Web of Science. Between 2000 and 2018 papers in Scopus increased by 4.94 per cent a year, meaning that recognised knowledge doubles every 15 years (NSB 2020, Table S5A-2). There has been a striking growth in the proportion of papers authored in more than one country, from only 1.9 per cent in 1970 to 13.6 per cent in 2000 and then 22.5 per cent in 2018 (Olechnicka et al. 2019, 78; NSB 2020, Table S5A-32). Further, national systems with research centres and doctoral training have spread well beyond the traditional science nations, the US and the Anglophone zone, Western Europe, Russia and Japan, to middle-income and sone low-income countries. For example, in 2018, there were 26 countries whose scientists authored at least 5,000 papers, in which the number of papers grew faster than 4.94 per cent per year, the world average. In 12 of those fast-growing countries, per capita income was below the world average of $16,635 PPP (Purchasing Power Parity). They included India, Indonesia, Brazil, Nigeria, Pakistan, Iran, South Africa, and also

China where per capita income was just below the mean (NSB 2020, Table S5A-2; World Bank 2020). Emerging national systems have been stimulated and facilitated by the global network. Using social network analysis (Scott 2017), Wagner et al. (2015) find that the networked global system has become more open to new members as it has grown, and new members are not wholly dependent on existing members. 'Network betweenness' has declined, meaning that a lesser proportion of communications pass through the leading countries (12; see also Wagner et al. 2017). Choi (2012) finds that links between scientists in different emerging countries are the fastest growing kind of connection (34).

As noted, growth and diversification are associated with changing geo-politics in science. The US spent £74.2 billion PPP on research in higher education in 2018 compared to £41.1 billion in China and £25.1 billion in Germany (OECD 2020). It remains strongest in high citation papers in most disciplines and has a long lead in biomedicine. However, China's scientists are now the largest producer of papers, in their second language of English; China is first in the world in high citation papers in mathematics and may soon achieve this level in computer science; and its leading university in physical sciences STEM, Tsinghua, is first in the world, ahead of MIT, in high citation papers in those disciplines. R&D and basic science output in East Asia are larger than in North America, and Singapore achieves citation rates comparable to Switzerland and UK in Europe. India is now the third largest producer of papers. In China, India, South Korea, Iran and Brazil science is growing as much or more in national collaboration as international links (NSB 2020, Tables S5A2, S5A32, S5A36-49; Leiden University 2020). The Euro-American duopoly is not as central as it was.

Inequality and homogeneity

Global science develops common knowledge goods in relation to shared human problems. In the ongoing cooperation on global climate change, the data are both interdependent and contextualised and research benefits especially from universal sharing (McCowan 2020). Open science has been crucial in forging the different Covid-19 vaccines (Lee and Haupt 2020). However, common goods can be captured by powerful interests and their commonality is often stymied in distribution

(Marginson 2016). The present potentials of the global science system are limited by structural inequalities and cultural homogeneity. Network analyses that highlight nodes and edges miss the dark spots: connections not made, untranslated conversations, under-valued knowledges, agents outside the network. There is also the rules of the network, legitimacy, the fashioning of agendas and contents.

Science combines the horizontal with the vertical. Cognitive accumulation, knowledge building, is partly collective and there is an irreducible moment of equality in every research conversation. There is also hierarchy of various kinds. As well as epistemic distinctions between truth/untruth and strong/weak explanation, there is the stratification of status/resources and structured injustice that lie between national systems, between universities, between disciplines, in journal rankings and inside the academic professions. These can colour epistemic distinctions (all else equal, a statement by a Harvard professor has authority). Ideas matter, and some subaltern scientists break through. However, this does not change the fact of two forms of inequality in global science: the exclusion of the vast bulk of knowledge in languages other than English, and the expectation that universal global knowledge is framed by Anglo-European and primarily Anglo-American cultural norms. Beyond the codified science in bibliometrics there is a wealth of other knowledge. Like published knowledge, not all of it has lasting importance. The point is that it is different.

English dominates global science. Ethnologue (2018) estimates that English is the first language (L1) of 378 million people, 5 per cent of the world's population, and second language of another 750 million. About a quarter of the world's population are competent in it (Ostler 2006). English has replaced Latin, French German and Russian to become the sole global language of science, due to the economic, political and military primacy of Great Britain and the US since the late eighteenth century. Ulrich's periodicals directory, a comprehensive directory covering 300,000 periodicals in different languages around the world (UlrichsWeb 2021), specifies that 69 per cent scholarly journals are published in English. English bulks larger in the more widely used and more selective citation indices: 80 per cent of all indexed journals in Scopus, 89 per cent in the Science Citation Index Expanded (SCIE), and 90 per cent in the Social Sciences Citation Index (SSCI) (Web of Science 2020;

Elsevier 2020). The low proportion of non-English journals is a result of selection and exclusion; it does not reflect the publication volume of those journals. For example, Ulrich's directory lists 9,857 scholarly journals published in Chinese, but only 42 are indexed by the Journal Citation Report of Web of Science (UlrichsWeb 2021).

The proportion of papers that are in English medium is higher than the proportion of journals, some of which are multi-lingual. In 2018, 95.37 per cent of Web of Science publications (including journal articles and other formats), and 92.64 per cent of Scopus publications were in English. The second language in Web of Science is Spanish with 1.26 per cent, and in Scopus is Chinese with 2.76 per cent (Vera-Baceta et al. 2019). Publications in the English language also enjoy higher visibility and citations. An analysis of 1,328 articles published in six science journals from five countries showed that 'articles written in English have a higher chance of being cited and a higher number of citations than those published in other languages' (Di Bitetti and Ferreras, 123).

The dominance of English shows in another way, in the asymmetrical patterns of translation between English and other languages. According to UNESCO's *Index Translationum*, almost half of all translations are from English to other languages, while only six per cent are from other languages to English (Naravane 1999). This again means that little non-English knowledge finds its way to the common pool.

In an account of global English that verges on the triumphal, Crystal (2003) notes in passing that 'it is possible that people who write up their research in languages other than English will have their work ignored by the international community' (16). Yes. L1 speakers of Mandarin Chinese and Spanish, both of whom outnumber L1 speakers of English, must become bi-lingual to participate fully in global science. Chinese scientists have done so but in Russia and Japan, the longstanding practice is to translate incoming articles at the border into the national language for internal circulation, an approach fashioned in each of nineteenth century Meiji Japan and Soviet Russia to insulate the nation from full exposure to the West. Neither group of scientists can fully engage in global conversations. Arguably, scientific output is adversely affected, both in the two countries themselves (for Japan, see Marginson

2010), and indirectly in the larger scientific world, which never accesses the original scientific work published in each of Japanese and Russian.

It is important to acknowledge that the global scientific knowledge that functions as universal knowledge is also culturally specific and that its claim to universality is naturalised by the normal operations of science. Along with the single global language, Euro-American (and again, primarily Anglo-American) organisations control the processes whereby knowledge is formed, circulated and codified. In global publishing and indexing the top ten publishers, all based in Europe or the US, own over half of the global market (Wischenbart and Fleischhacker 2020). Clarivate/Web of Science, Elsevier/Scopus, and Google Scholar are headquartered in the same region. Editors and peer reviewers, the 'gatekeepers' of international journals, demonstrate some geographical diversity, with China ranking second with the UK for its supply of reviewers (Publons and Clarivate Analytics 2018), but the US ranks first for the number of editors, peer reviewers, and reviews (see Mazov and Gureev 2016; Publons and Clarivate Analytics 2018). This contrasts with the greater diversity of contributors, particularly from emerging countries (Publons and Clarivate Analytics, 2018). Further, the global rules of intellectual property are from Western legal traditions; and Anglo-Europeans lead in the standards and conventions of self-managing science.

King (2011) remarks that in science 'normative processes may be as "closed" to outsiders as are state power and commercial markets, and may not be quite as illustrative of meritocracy as Merton ad other assumed' (369). Vessuri (2014) notes that the core journal lists in bibliometric collections are composed by a process of 'self-selection', while much work in national languages is ignored, made invisible. The result is that the non-English-speaking jurisdictions appear as intellectually impoverished, though they are not (654). 'It becomes evident that the mainstream has been self-built on the supposition that outside there was backwardness and lack of academic value' (Beigel 2014, 619). Santos (2007) describes the imposition of an inside/outside dualism, a 'radical denial of copresence' (48), which continues the intellectual outlook of the colonial period. The dualism creates a distinction between universal science and localised non science – though all knowledge is local, and, as

Mato (2011) puts it, ‘intercultural collaboration indispensable’ (409). This creates a recurring dilemma for non-English-speaking science systems. Ministries and universities try to ‘internationalise’ research by adopting the norms of global academia and incentivising publications in internationally-indexed journals (e.g. Xu 2018 on China). Here ‘internationalisation’ is a double-edged sword (Chen 2010; Yang 2014), for it creates conflicts of identity and purpose. Publishing in global journals means that theories and methods must be reworked for Anglo-American templates, articles that do not tick the standard boxes are desk rejected as not rigorous; and national agendas and topics are displaced by ‘global’ topics often localised to American society. Vessuri et al. (2014) refer to subaltern universities that contribute to ‘problems affecting mostly rich countries (a kind of foreign aid in reverse)’ (p. 649). Olster (2006) remarks that English-speaking countries are largely monolingual and ‘the world has as yet exacted no price for this’ (542). Not so. The price of cultural uniformity is loss of diverse knowledge.

The pattern of homogenous language, norms and knowledge is powerfully advanced by the leading Anglo-American research universities. The Leiden University (2020) ranking carries data on Web of Science papers from 2015-2018 in the top 5 per cent of their field by citation rate. Of the leading 50 universities on this measure, 54 per cent were from the US and 78 per cent were Anglophone. Global university rankings embody various criteria, but all are grounded in the customary profiles of the top US-UK universities: papers in English-language dominated bibliometric collections, citations, number of leading researchers, Nobel Prizes, internationalisation of faculty and students – meaning not Cambridge going out to the world but a supplicant world coming to Cambridge (Friedman 2018) – and surveys of university reputation (ARWU 2020; THE 2020; QS 2020). In this manner ranking defines, affirms and recycles the Anglo-American domination of science (Shahjahan et al. 2017). At its institutional peak, global science is more unequal than the global economy. The US had 20 per cent of world GDP in 2018 (World Bank 2020), 34 per cent of the top 1 per cent science papers in 2015-18 and 70 per cent of the universities that led on this indicator (Leiden University 2020). The leading universities are more faculty governed than most others (Shattock and Horvath 2019). The cultural forms of global science are installed not through coercion by neo-imperial nation-states but in day-

to-day institutional practices and autonomous professional habits. Whether scientists across the world are motivated by curiosity and cognitive accumulation, or status and preferential attachment, they are pulled gravitationally towards the familiar hierarchy and the works fashioned by its peak.

The global hierarchy in science draws trenchant critiques from non-English speaking and post-colonial countries (e.g. in addition to the above Boidin et al. 2012; Mbembe 2016; Stein 2019; Posholi 2020). The exclusion of endogenous (indigenous) knowledge is much remarked (e.g. Connell 2014, 212; Heleta 2016, 2; Nyamnjoh 2019; 2; Dawson 2020, 75). Some discussion focuses on the social sciences, where language, national context and variation play a larger role than in physical sciences. Critical scholars adopt varying strategic positions. Some reject existing science wholesale, asserting alternative knowledges as part of a process of decolonisation, a position, however, critiqued in Roy (2018). Others call for not the abolition or subordination of monocultural science but its dethroning and democratisation, and its supplementation by knowledges previously marginalised or ignored, in an open framework. ‘We don’t want another system of intellectual dominance’ (Connell 2014, 218). Many simply want a broader inclusion of voices and localities. Common to all of these positions is the desire to advance subaltern agency.

The multi-polarisation of science has been transformative. Yet up to now it has meant that China, South Korea, Singapore, India, Iran and others are now better at doing Anglo-European science, and primarily Anglo-American science, as bench-marked against Anglo-American criteria. The asymmetry is inescapable. Though English-speaking scientists seem to move seamlessly between the local, the national and the global, for other scientists there are always frictions if not barriers. Non Anglo-American and emerging systems and persons have more agency than either the bibliometric collections or the centre-periphery model acknowledge, but those systems and persons can exercise that agency in codified global science only on someone else’s terms. As Beigel (2014) suggests, the ultimate strategy is not to assert the possibility of science in emerging countries, or the possibility of autonomous science – both are already established facts – but to struggle for the plurality of models, standards, institutions, professional practices and values. In this,

the scholarship of knowledge and science is one element with an important role to play.

The centre-periphery model

The primary field of scholarship on global and national science is scientometrics, which investigates scientific networks using quantitative analyses of bibliometric data (for reviews of the field see e.g. Mingers and Leydesdorff 2015; Chen and Chen 2016; Patelli et al. 2017). A strand of this literature focuses explicitly on inequality and agency (e.g. Chinchilla-Rodriguez et al. 2018a; Chinchilla-Rodriguez et al. 2018b; Chinchilla-Rodriguez et al. 2019). However, for the most part scientometrics and related science studies are not strongly theorised. The most utilised framework, applied with varying rigour, is world systems theory. Concepts from that theory, and the related North-South binary, also appear in development studies and comparative education in discussion of global inequalities.

In *What is Global History?* (2016) Conrad refers to the 'internalist' approach in social theory, the idea that social phenomena should be analysed wholly within the boundaries of a single society, as if societies are 'self generating' and social change is 'always of a society's own making' without regard to external connections and influences. Conrad comments that this horizon structures the work of Marx, Weber, Parsons, and Foucault (88). In contrast, world-systems theory goes to the other extreme. All determination is at the level of the world as a whole, without regard for distributed agency. This could be called the 'externalist' approach, and it is just as one-sided as work that neglects the world level.

The idea of a global structure of centre-periphery or 'core-periphery' relations originated with Argentine economist Raul Prebisch and the 1950s work of the United Nations Economic Commission for Latin America, which he headed, and dependency theory (Rojas 2013, 44-45; Wallerstein 2004, 11) but is now largely associated with Wallerstein's world-system theory. This is a narrative of European and North American dominance in which all nations are incorporated into the expanding Euro-American world-system grounded in the capitalist 'world-economy'

(Wallerstein 1974, 390; Wallerstein 2006, 1; Conrad 2016, 33-34). Wallerstein argues that ‘the only kind of social system is a world-system, which we define quite simply as a unit with a single division of labour and multiple cultural systems’. The division of labour is three-way, between countries at the world ‘centre’ in the US, parts of Western Europe and probably Japan, which have relatively strong states; the bulk of nations on the ‘periphery’ where states are endemically weak or non-existent, and those located in the intermediate ‘semi-periphery’. The semi-periphery acts as a periphery to the core and as a core to the periphery. Each of ‘the various sectors or areas within are dependent upon economic exchange with others’ (Wallerstein 1974, 390). For example, centre countries command advanced technologies and manufacturing while periphery countries provide raw materials and cheap labour and purchase the centre’s manufactured goods at exploitative prices. Countries in the periphery and the intermediate semi-periphery are locked into position. It is very difficult to move from one category to another. The ‘totality’ at the world level is decisive. At the same time, in world systems theory, the world level solely consists of nation-states. There are no autonomous global relations that crisscross and combine nations. Nor do individual nations have partial autonomy. They exist only in the rigid mosaic of nations, the world-system. As Wallerstein (1974) puts it bluntly: ‘There is no such thing as "national development"’ (390).

A key premise of Wallerstein’s argument is that there is limited political economic ‘surplus’ at world level and the world-system imposes a zero-sum competition between countries in terms of power. Wallerstein scales up Marx’s idea of the class struggle over surplus value in the capitalist economy, transferring it to inter-state relations between national economies. It is the limited surplus that fixes countries into the mosaic. For example, for a ‘semi-peripheral’ country to achieve core status it ‘must garner a heavy portion of the collective advantage of the semi-periphery as a whole to itself in particular’. It rises ‘not merely at the expense of some or all core powers, but also at the expense of other semi-peripheral powers… This is not "development" but successful appropriation of world surplus’ (Wallerstein 1976, 466). Hence world-systems theory firmly rules out the possibility of many semi-peripheral countries rising simultaneously. On the periphery, states are inevitably weak or non-existent because foreign capital controls local elites and blocks development

(Wallerstein 1974, 349). Wallerstein repeatedly emphasises that very few countries on the periphery and semi-periphery can move up though their own efforts (e.g. Wallerstein 1984, 7). In the mid-1970s he assigned a long list of countries to the semi-periphery, including Eastern and Southern Europe, Norway and Finland, parts of Latin America, Anglo settler states including Canada and Australia, Israel, Turkey, Iran, stronger Arab countries including Egypt, Indonesia, India, China, South Korea, Vietnam, Nigeria and Zaire (Wallerstein 1976, 465). In 1974 Wallerstein saw no end for his world system for at least another century (Smith 1979, 251). Three decades later South Korea, after state strategy and advanced manufacturing had secured a spectacular economic-social trajectory, with a global role as R&D powerhouse, knowledge-intensive exporter and cultural leader, was still languishing in the semi-periphery according to Wallerstein (2004, 30). If the theory says that Korea is subordinate do not let mere facts tell you otherwise.

Wallerstein is not a normative Eurocentrist. He began as an Africanist focused on the injustices of colonialism (Wallerstein 2013, 196); and his later work endorses Said's postcolonial critique of Orientalism and the value of multiple and subaltern perspectives (Wallerstein 2006). In science he argues for 'universal universalism' in place of 'Eurocentric universalism' (71-84; also Gundara 2014, 117). However, he believes that substantial change in the world-system can occur only if and when global capitalism is abolished (Rojas 2013, 30-31). This partly explains the wide take-up of the centre-periphery model in science studies. Wallerstein's notion of an inevitably Euro-centric world is readily agreed by those who, unlike him, welcome Euro-American domination, bask in the alleged cultural superiority of the world centre, and see capitalism as not just inevitable but desirable.

In an early and prescient critique Smith (1979) takes issue with Wallerstein's 'insistence that it is not internal characteristics of particular countries so much as the structure of the international system – particularly in its economic aspects – that is the key variable' (248).

> Part and whole must be comprehended at the same time as an aspect of each other and as analytically autonomous – although the degree of relative independence will obviously be more or less complete depending on the historical moment. The theoretical consequences are clear: systems composed of complex parts may expect change to come not only from the evolution of the whole … but also from developments within the parts whose movements are endogenously determined (Smith 1979, 259).

Smith finds that Wallerstein's insistence on determination by the 'totality' leads him to underplay the importance of contextual factors, the possibility of national variations, and the potential of nationally based agency to escape the dependence trap, especially through 'the organisation of the state', which for Smith (1979, 260) is often primary. The state's role is not necessarily reducible to either class interests at national level or the world system at global level (270-271). Strong states can precede economic development, as in nineteenth century Meiji Japan (264). The assumption that peripheral economies are captured by foreign capital, which blocks development, does not always hold. The system of North-South relations is 'too weak to determine all aspects of change in the South' (287). As it turned out, within two decades Wallerstein's world system division of labour, which seem to apply to some countries, some of the time, in the 1960s, was being remade by global supply chains, the move of manufacturing to emerging countries, and a surge of state building, industrialisation, modernisation and growth of science and technology.

Applications to the study of science

The centre-periphery distinction is often referenced in studies of science (e.g. Gazni et al. 2011, 323; Adams and Gurney 2018, 1) and higher education (e.g. Altbach 2009; Chankseliani 2017). Arguably, there are several reasons for this. As noted, it sits comfortably with a Eurocentric perception of the world. The tiered system fits with the operating pragmatics, and dreams and imaginings, of the normally experienced world of science in which Stanford or Oxford really are at the centre. Moreover, centre/core and periphery from Wallerstein chime exactly with the same terms in social network analysis, a very different knowledge. Hence it looks like a

short journey from world-systems to scientometrics, though it is not, and the transfer leads to ambiguities, as will be discussed.

In some science studies, centre and periphery simply function as tiers of a hierarchy, but other studies develop a fuller application. Schott (1998) uses mobility patterns and citation data to develop an empirical picture of stratification at world level. Ties accumulate at the centre (112), scientists from the periphery gain status by visiting the centre (127) while the centre is inwardly focused and complacent (137). The centre-periphery idea is invoked in critical studies of social science (Mosbah-Natanson and Gringas 2013; Helibron 2014, 685; Yang 2019). In social science disciplines Eurocentric culture imposes directly on the work of scholars from outside Euro-America with a different outlook, and they have less presence in global publishing than do their counterparts in the physical sciences. Xu (2020) defines the centre-periphery dual as a West/non-West divide.

In scientometrics, Leydesdorff and Wagner (2008) adopt a centre-periphery framework and seem to interpret the evidence to preserve the narrative (323); though other papers by them and colleagues explicitly reject centre-periphery and assert the openness of the global system and dispersed agency within it (Wagner and Leydesdorff 2005, 1610; Wagner et al. 2015; Wagner et al. 2017). Chinchilla-Rodriguez at al. (2018a) and Chinchilla-Rodriguez at al. (2019) use world-system concepts when investigating agency and dependency in emerging countries, though they find that citation counts, author order and the proportion of papers that involve international authorship are blunt tools for studying relations of power. Choi (2012) combines social network analysis with employment of centre-periphery ideas (26), though the focus on newly rising science systems in Turkey and South Korea seems to contradict Wallerstein's premises. Likewise, Jang and Ko (2019) frame their study of high energy physics in centre-periphery terms, for example pointing to the advantages that the 'core group' secure from international collaboration (440) but go on to explain the often successful strategies of 'latecomer countries' to the disciplinary field.

This is the unrecognised ambiguity at work. The term ‘centre’ in social network analysis differs from the meaning of centre in Wallerstein. Centres in social network analysis are concentrated connections (Scott 2017, 95-111) that are identified by a technical process of quantification, not necessarily as one half of a dominance/subordination dyad or an exploitation/dependent dyad. In network analyses there can be multiple centres and relations between centre and periphery are not necessarily zero-sum. However, when they buy in to world systems theory, scientometric studies of networks can slip into assumptions about a locked down world order, inevitable Eurocentrism and low agency in emerging systems. One such case is *The Geography of Scientific Collaboration* (2019) by Olechnicka et al., where the authors apply world-system theory to science consistently and in depth.

Problems of the model

A closer look at Olechnicka et al. (2019) highlights problems of the centre-periphery in science studies. The authors define their assumptions in ‘The logic of centre and periphery’ (102-105). Stating that ‘structural hierarchy is an immanent feature of global science, as it is in the case of the overall world-system’ (105), the authors recycle the original:

> The world of science reproduces the global structure of centre and periphery. This can be further explained in the light of the world-systems theory crafted by the influential American intellectual Immanuel Wallerstein. Core and periphery play complementary roles in the global system. The core is at the forefront of socio-economic and technological development, while the periphery provides cheap labour and low-processed resources. In the case of science, this is manifested by the fact that new ideas are generated predominantly in the centre and then imitated in the periphery. Further, the world system is composed not only of core and periphery, but also of semi-periphery… The hierarchy of the global scientific system is thus multi-level. At the same time, the system is segmented into macro-regions within which horizontal relations are dense. Horizontal relations occur especially among core countries, while between

> core and periphery relations tend towards domination and subordination (Olechnicka et al. 2019, 102).

Because the world-systems theory used by Olechnicka et al. (2019) lacks an explanation of globalisation, they fail to identify a global system distinct from national science. Like many scholars of comparative national science, beginning with May (1997) and King (2004), whose data are designed for use by single national governments, Olechnicka and colleagues read the global science system through the lens of 'methodological nationalism' (Wimmer and Schiller 2002; Shahjahan and Kezar 2013). For example, they arbitrarily divide the data on international collaborative papers between participant nations (Marginson forthcoming). Without the full global picture, they can provide no clear explanation for the main historical changes of the last three decades: the rapid growth in global papers, the spread of science systems to an increasing number of countries, and the 'increasingly central role of collaboration' (Olechnicka et al. 2019, 2), which is the primary topic of their book.

They advance tentative reasons for the boom in international scientific collaboration. These explanations miss the dynamism and openness of networks. The authors point to links between international co-authorship and citation performance that motivate scientists and nations to collaborate, especially peripheral nations. Collaborating at a distance can enhance the potential for complementarity and cutting-edge work, though the cost-benefit equation is unclear (Olechnicka et al. 2019, 96-101, 177). However, the main explanation is drawn from the pre-given centre-periphery narrative. 'Research collaboration is one of the means that the centre uses – even if unintentionally – to ensure its scientific domination over the periphery' (102). Centre countries have less motive to collaborate. It 'can even lead to a decrease in performance'. However, power has its rewards: they use their central positions 'to control knowledge flows and thus maintain a competitive advantage'. They also set 'the rules of the game' and establish 'the institutional framework in which global science operates'. Further, 'the core imposes its research agenda on the periphery, an agenda 'not necessarily consistent with the needs and wants of the periphery'. In addition, centre countries 'attract talented scholars from

peripheral countries' triggering one-way flows, 'brain drain'; and researchers on the periphery often serve as 'subcontractors or routine research providers for core countries'. For their part authors from the periphery must collaborate upwards for recognition, publications and international finance (103). Collaboration nevertheless can help their nations to develop science (105) and boost research performance, provided centre country authors are in lead position.

Here there are insightful points about centre countries dominating science agendas, and unequal mobility flows (though the inclusion/exclusion effects of global language are missed). As Cantwell (2021) remarks, people flows in science come closest to replicating the centre-periphery imaginary in real life, especially flows into the US, UK and Swiss science systems (though not all strong science countries are migration magnets). The description of the exploitation of peripheral researchers echoes the influential contribution of Hountondji (1997). However, Olechnicka and colleagues' account of asymmetrical science is also reified and overstated. Arguably, centre-periphery explanations of the motives of scientists from centre countries are insufficient, a point noted by Wagner and Leydesdorff (2005, 1610; see also Chen et al. 2018, 158). When scientists from stronger and weaker science countries collaborate, not all motives are calculative or transactional and not all moments are hierarchical. On one hand Olechnicka et al. (2019) do not fully capture the hubris at the centre amid one-way US citation (NSB 2018, Table 5-28) and people flows. On the other hand, cooperation is at least partly driven by cognitive accumulation and those relations are more horizontal than suggested by Olechnicka and colleagues. They also underplay the agency of countries and scientists outside the leading science systems, including empirical patterns of first authorship and nation-only collaborations (Chinchilla-Rodriguez et al. 2018a; Jang and Ko 2019), and the capacity to link to science in other emerging systems (Choi 2012). It is not inevitable that those seen as subaltern researchers are confined to secondary tasks, given their capacity to make new connections within the network. Global science is modulated by Eurocentrism and persistently devalues others, but it is also open.

Not surprisingly, Olechnicka et al. (2019) also struggle with the geo-politics. Like all centre-periphery scholars they must fit changing national systems into Wallerstein's

three-way classification, and multi-polarity into a fixed Eurocentric order. They identify a Wallerstein sized ‘core’ of the world-system on the balance of citation flows. Parts of the US and Germany, and the UK, Switzerland, Netherlands and Japan are knowledge ‘sources’; the rest (including smaller systems with high average citations that because of their size extensively cite foreign papers), are mere knowledge ‘sinks’ (16). To use citations as a uniform system of value, despite the extensive scholarly criticism of this position (e.g. Tahamtan and Bornmann 2019), is to take as given the bibliometric definition of knowledge, including its culturally loaded pattern of exclusions, and to accept the citation biases of a science system in which well represented scientists primarily cite their own nationals (NSB 2018, Table 5-28). The performance hierarchy they describe is a self-fulfilling prophecy, and one from which there is little escape: individual countries rarely break ‘the vicious cycle of lasting peripheralisation’: low performance triggers low funding, and brain drain triggers low performance (105). There is not much scope here for state strategies. So far this is pure world-systems theory, underpinned by the circularity of performativity.

On the other hand – and here the authors move out of the centre-periphery model to the different notion of ‘centre’ that is used in social network analysis – the quantitative analysis of patterns of collaboration reveals there has been ‘a great shift of world-wide knowledge flows’ (93), due to the growth of science in East Asia, the rise of China to a prominent position in the network, India and flourishing secondary regional nodes (92-93). Going further, they argue that ‘the recent examples of Singapore, South Korea and, in particular, China indicate that transfer from periphery to semi-periphery, or even to the core, is possible’ (105). Has the Eurocentric world-system run its race? Not quite yet.

China is a puzzle for Olechnicka et al. (2019). It is ‘a new scientific superpower’. This new status has been achieved by ‘massive investments from the Chinese government’. However, there are ‘cultural and organisational obstacles to scientific collaboration’ that ‘may hinder further expansion of the research sector’ (177). The research environment ‘can be dubbed uncollaborative’. This is ‘deeply embedded in Chinese culture and history’. The ‘grim legacy of the Cultural Revolution’ of 1966-

1976 ‘still casts a shadow on Chinese scholarship’. Further ‘the Confucian tradition does not support collaborative behaviour. It attaches great importance to the social hierarchy, loyalty, and subordination to authority. Chinese education traditionally does not encourage critical thinking’ (155). The culture of science is not intellectually meritocratic. *Guanxi* networks not only shape collaboration but also determine access to resources. Talented returnees from abroad can lack access to those networks. Rules, centralised funding, ‘all-pervasive bureaucracy and central planning’ all hamper collaboration. ‘The political system in China hampers the freedom of choice of scientific topics and partners for collaboration, and the freedom of speech. As such, it is in conflict with the notion of innovativeness and creativity’ (156). It seems that science in China is not fully bona fide science, not creative in a Euro-American sense. The empirical weight of China’s science, which showed in the network analysis, begins to evaporate once the authors bring their cultural assumptions to bear on it. Eurocentrism is briefly dethroned but it is almost immediately reinstated. Olechnicka and colleagues have joined the long list of Western commentators that forecast, unsuccessfully, a ‘glass ceiling’ that must block the progress of science in China (e.g. Altbach, 2016). Again, some of the points are true, like the role of *guanxi*, rules, lack of freedoms in some disciplines, but they are embedded in a highly normative and selective picture that protects the world-system vision. Olechnicka and colleagues want to find a Wallerstein world, and, despite the data, they find a way to do it.

Other scholars work hard to reconcile world-systems theory with China. Mulvey (2020) discusses China’s role in higher education in relation to Africa. World systems theory says China is ‘semi-peripheral’, not a colonial country of the ‘North’, but its relations in Africa are asymmetrical. Mulvey develops the idea of ‘semi-peripheral (post) coloniality’ to explain China in Africa. This enables him to protect world systems theory by adding another layer of complexity, but it is ambiguous and opaque. Others loosen the definitions. Helibron (2014) asserts a global system of social science whose ‘predominant characteristic’ is ‘a core-periphery structure with a duopolistic Euro-American core, multiple semi-peripheries and a wide range of peripheries’ (685). At this point it is better to stop talking in terms of categories and start talking in terms of cases. Gymnastic redefinitions and ambiguous applications,

with concepts that are alternately too rigid and too loose, are signs of a paradigm in decay. It is not worth the strenuous efforts being made to preserve it.

Conclusions

In sum, the singular world-economic structure of world-systems theory negates (1) the autonomy of global relations, (2) the autonomy and agency of nations and (3) the potency of context and culture. In this framework cultures vary, but a homogenous geo-political economy over-determines all. Applying this package of assumptions to science, and attaching it to scientometric paper and citation counts and social network diagrams, as if all 'centres' are the same as each other, leads to several problems in the study of science.

First, as noted, to argue that national science systems are determined by political economy at world-system level denies the possibility of autonomous science – national or global – *and* of the national science policy that many scholars in scientometrics serve (Cimini et al. 2016). For example, it implies that national resources for science are directly correlated to national income, though that is not always the case. While rich countries spend more than poor countries national, science funding is surprisingly variable (OECD 2020). Second, it is never explained *how* 'the world of science reproduces the global structure of centre and periphery'. What are the mechanisms of correspondence? Is science tied to the economy through the platform capitalism of publishing companies, or commercial research and consultancy, or does the state pattern science as the servant of corporations? While there is profit-making at the edge of science, and while science intersects with the economy in the zone where technological innovations emerge, it would be audacious to claim there is a determining mechanism; that either publishers, big pharma and/or neo-liberal states have wholly suborned professional science to the law of value in the economy. Many people who generate basic science are workers, and some are entrepreneurs, but they not wholly programmed by profit-making corporations. They work for universities, retain collegial forms and agendas and often generate their own ideas.

Third, there is the larger problem pointed out by Smith (1979): world-systems theory's inability to grasp the political potentials of emerging nation-states. These potentials are evidenced in science by the differing successful strategies that have been used to build national systems, from an emphasis on international collaboration (e.g. Singapore), to a primary focus on national collaboration (e.g. Iran), and countries that have combined the two (e.g. China). It is notable that these various simultaneous strategies have not been inhibited by a zero-sum battle over a fixed 'surplus' in which one semi-periphery country only succeeds at the expense of all others. A large group of countries on Wallerstein's semi-periphery, and some on the periphery, have built science systems at the same time. Fourth, there is the failure to grasp the role of political-cultural variations in state strategy and the potency of cultural factors in general (except for European-heritage culture) – for example the way that the statecraft and self-cultivation of post-Confucian cultures has facilitated accelerated science building in China, South Korea and Singapore (Marginson 2011).

Finally, because the centre-periphery literature does not fully grasp the fact of an autonomous global network, it is unable to fully explain the mobilisation and collaboration of globally active scientists. According to the world-systems theory script, scientists at the Eurocentric centre have autonomy, others must abase themselves, and all have been fixed in place on the basis of citizenship or residence. In the real world most practising scientists, wherever they are from, can form collegial global networks. Further, in not seeing the autonomous global system for what it is, centre-periphery scholars cannot fully grasp the relations between globally active scientists and nation state strategy, a pivotal issue. Wagner et al. (2015, 11-12) highlight this, pointing to potential tension between global collegial networks and national government agendas. On the other hand, structuring this relationship effectively has been a key to China's success in science (Marginson 2018).

The fact that Olechnicka and colleagues do not fully acknowledge networking, growth, diversification and multi-polarity in science is paralleled in Wallerstein's unwillingness to fully accept the facts of South Korea and China. Rather than clinging to Eurocentrism for its own sake it is clinging to a centre-periphery ideology

– nurtured in the bi-polar cauldron of the Cold War and predating post-1990s globalisation, networks and the growing role of Eurasia (Macaes 2018) – that has long been decoupled from the history of science. However, it is a dangerous kind of obsolescence. It normalised hierarchies that can be refused. It perpetuates the world-system it means to critique by diminishing the potential of agency.

Hegemony and beyond

Developments in global and national science have inverted world-system theory's idea of the relation between political economy and language-culture and changed perceptions of the drivers of inequality. In pre-Internet science, the Euro-American duopoly was upheld by on one hand geo-economic stratification, on the other hand by the leading universities, language and monoculture. In world-systems theory, and elsewhere, it was assumed that the geopolitical economic base was decisive, shaping the superstructure of language, universities, journals, and Anglo-American scientific processes. The growth of a distinctive global science system in a more multi-polar world has upended the old base/superstructure assumption. It is clear that in science economic capacity and scientific output have become more widely dispersed. The US is still number one but there are major powers outside the Euro-American group. Yet the language, processes and agendas of science have not changed, and the map of leading universities is only slightly modified. History shows that language-based control can be long-lasting and profound: consider the Qin Dynasty's (221-206 BCE) standardisation of written language in China, which facilitated a unified polity that still exists, and the universalising role of Latin in the political-cultural domination of the medieval Catholic Church in Europe. This suggests the Anglo-American domination secured by language, institutions and culture trumps raw economic power in science (and probably in other knowledge- and culture-related areas like communications and media). This means that while the material need to build science in emerging countries continues, the struggle to pluralise science is partly about culture, processes and institutions. Adapting Amartya Sen's argument in *Development as Freedom* (2000), the building of free intellectual agency is a condition for the building of the necessary scientific infrastructure, as well as vice versa.

If the centre-periphery model is obsolete, what constitutes a better framework for understanding science? Arguably, this requires two elements: scale, and hegemony. Following the ontology of Smith (1979) and the 'glonacal' spatiality (Marginson and Rhoades 2002), it can be argued that the different *scales* in science – the global dimension, the international relations of states, and the national, regional and local practices of science – are at one time interdependent, and partly autonomous. Change in science can occur in any scale, though at any time one or another scale can be decisive. World-systems theory's debacle in prediction, the manner in which it became decoupled from the actual history of science (and of the world order) shows that deductive reasoning from generalisations at the level of the stratosphere is a precarious method. Context and contingency matter. Theories are tools to be mixed and matched at need, not iron-clad formulas. One size does not fit all, a nuanced case by case approach to understanding science is essential, and at any time the global network, national science systems, institutions, and individuals all have agency. Each of several strategies standalone growth and local consolidation, global engagement, or a combination of these – can enhance national systemic and epistemic agency in science.

Second, the concept of *hegemony* offers a more comprehensive, flexible and supple explanation of power and inequality in science than does centre-periphery. It also more directly specifies domination/subordination; while at the same there is less closure, less of a zero-sum ontology. In Gramsci (1971) 'hegemony' refers to control though the management of consent and participation. He emphasises the role of language and cultural mechanisms. Though Gramsci focuses on relations of class, the idea of hegemony has been more broadly applied. In *Power: A Radical View* (2005) Lukes, moving beyond coercion and majority rule, discusses 'the mobilisation of bias' (20-21) and control over institutional processes and agendas (25-29). Ordorika (2003) refers to 'the process of shaping and incorporating perceptions, cognitions and preferences into a dominant ideology' (27). Institutions play a key role in the exercise and expression of hegemony and in higher education. As discussed, they sustain agencies and processes (e.g. journal hierarchies and topic selection) which calibrate value in science on the basis of the hegemonic order. In *Empire* (2000) Hardt and Negri describe a networked global system of power bound by a

single logic of rule, in which US political economy and culture are central but do not exercise blanket control. Their idea of 'empire' is a loose form of sovereignty held together by cross-border political economy, cultural practices and common ideological forms, that expands without limit across the whole global space (p. xii-xv). Hardt and Negri were writing at the highpoint of Anglo-American globalisation in the late 1990s. The empire they describe is now disrupted by multi-polarity (Pieterse 2018; Macaes 2018). Yet it seems to persist longer in science than in geo-politics as a whole. These formulations help to explain the inside/outside binary in global science. They also suggest counter-hegemonic strategies.

Ecology of knowledges

Though science, like most collective and common goods, is subject to unequal relations of power, this does not exhaust its potentials. The purpose of cognitive accumulation is knowledge building, not the building of systems of power. However, collegial global science, like national science systems and institutions, can be annexed to one or another configuration of power. The question is how to develop momentum for the democratisation and equalisation of science – how to understand the problem, and how to achieve the goal.

Globalisation fosters both cultural homogenisation and cultural heterogenisation (Held et al. 1999): it brings people face to face with difference but can do so only on the basis of common templates. At present global science works just one side of the globalisation dyad: it fosters homogenisation and it downplays recognition of difference. Is it realistic to expect relations of power that are more than flat network plus Anglo-American content? Is it possible to evolve a configuration of science with multiple centres, countries that value national-cultural diversity (e.g. as in some interpretations of the Chinese *tianxia*, 天下), plural global systems, and continuous inter-cultural conversations? It is hard work to create templates embodying diversity, as the long process of designing decision-making in the EU has shown – and that is diversity within Europe only. Nevertheless, the conclusion of the above analysis is inescapable. The next step in the globalisation of science and social science is a move from cultural homogeneity centred on the old world order to something like a unity-in-diversity approach – to work not with a centripetal and stratified knowledge

system, but with a knowledge system that recognises and respects the fuller corpus of languages, theories, concepts and methods. If multiple perspectives are to be valued in science and social science, so that more solutions can be debated, this requires not just the resources and specialised capabilities to make knowledge, it needs the cultural freedom to do so.

The ontology of a more diverse approach is well defined. Boidin et al. (2012) argue for the dethroning of hegemonic knowledge and the adoption of a 'pluri-versal' rather than 'universal' approach to knowledge (2, 36; Dawson 2020, 82). The idea of pluriversal knowledge recurs in both the Latin American and African decolonial literatures. Mbembe (2016) specifies a 'pluriversity' in place of a university, which would have:

> … a process of knowledge production that is open to epistemic diversity. It is a process that does not necessarily abandon the notion of universal knowledge for humanity, but which embraces it via a horizontal strategy of openness to dialogue among different epistemic traditions (Mbembe 2016, 37).

Santos (2007) proposes as the way forward recognition of an 'ecology of knowledges' in place of 'the monoculture of modern science' (66). He emphasises 'sustained and dynamic interconnections between' heterogeneous knowledges, 'without compromising their autonomy' (66), and also intercultural translation. 'This requires renouncing any general epistemology … not only are there very diverse forms of knowledge of matter, society, life, and the spirit, but also many and diverse concepts of what counts as knowledge and the criteria that may be used to validate it' (67). Santos does not seek to discredit scientific knowledge, but to promote 'the interaction and interdependence between scientific and nonscientific knowledges' (70), including endogenous knowledges (see also Connell 2014, 218). This does not mean anything goes, or that all truths have equal status, it means that structural mechanisms of exclusion are discarded. Openness is crucial.

> The novelty of subaltern cosmopolitanism lies, above all, in its deep sense of incompleteness without, however, aiming at completeness … The diversity of the world is inexhaustible and … such diversity still lacks an adequate epistemology. In other words, the epistemological diversity of the world does not yet have a form (Santos 2007, 64).

In practical terms, focusing on existing science, one step towards epistemological diversity is to move from sole reliance on global English to a multi-lingual publishing and translation regime, within a defined common pool that becomes the primary repository in each field. English remains the language of common use but every effort is made to capture and reproduce the range of knowledge in diverse languages, as part of the common pool. Multiple language papers would become core to the publishing mission, so that all global field journals, and leading national language journals, would be available in at least the major languages (some journals already do this). The languages with over 100 million L1 speakers and/or 130 million L2 speakers are English, Mandarin Chinese, Spanish, Hindi, French, Arabic, Russian, Bengali, Portuguese, Indonesian, Urdu and German (Ethnologue 2018). Given the profit rates secured by the major publishers (Tennant 2018) they could finance translation without overturning their business model. Developments in technology and machine translations are facilitating multi-lingual publishing. Citation counts could aggregate the different versions of the one text. In addition, academic book publishers would facilitate translation of books, not just from English to other languages as predominates at present, but all languages to each other. The real cost of this regime would be reduced if publishing was solely online. The increased cost of multiple language conversations must be set against the vastly larger pools of knowledge created.

It is not that publishers alone are the magic key. Commercial publishers will not abandon their successful business model until and unless there is a change of outlook in universities across the world, and above all in collegial scholarly associations in networks. Governments, universities, funders, scientists and other scholars can actively support language diversity in national and global research practices, as promoted by campaigns like the *Helsinki Initiative on Multilingualism in*

Scholarly Communication (2019). Government support brings with it normative and resource power, though it has to be said that nations by themselves are rarely very effective in dealing with cross-national cultural problems. Global agendas depend above all on global agents, in this case autonomous collegial networks. Science will not move as a whole. Reform in individual disciplines is the path to structured plurality. When new norms and expectations form in, say, particular social science communities, this can trigger momentum for change in other fields.

Reform to language protocols in itself does not turn the world upside down. Science in some countries will still be subordinated. Nevertheless, multi-lingual publishing of current academic knowledge (whether part of the existing pool or not) would be game-changing, upending existing expectations, discomforting some without excluding them, while advancing others. This in turn would help in extending the common pool to subaltern knowledges outside the English-dominated academic world. Prior to the larger unfolding of diversity, much can be done. In the self-regulating science system, the professional habits of professional scientists reinforce structural injustice, but different habits can transform it. Each monocultural scientist that starts to work across language divides or draw on endogenous insights; each editor curious about diverse contributions who exercises judgment more constructively than exclusively; each cross-cultural group founded in equality of respect; each person who thinks about what Eurocentrism means, and abandons the locked imaginary of ‘centres’ and ‘peripheries’. All make a difference. It is in the multiplication of these small steps that the ecology of knowledges really begins.

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