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The Geography of Scientific Collaboration – From the Perspective of 2021

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Abstract. Two years ago the publication of the monograph *The Geography of Scientific Collaboration* the authors discuss what issues would have been addressed if the book was written today. Three interrelated matters come up front. The first is the impact of the COVID-19 pandemic on scientific collaboration in both positive and negative ways, also from the geographic perspective. The second is the rise of vistual conferences with various benefits and challenges they bring, including their inclusivity and environmental impacts. The later is the last issue discussed in the article. The authors identify the environmental effects of academic mobility as one of the key issues that should be addressed by smart policies for scientific collaboration in the future.
Keywords: COVID-19 pandemic; virtual conferences; environmental effects

Steve Fuller, Nico Stehr and Stephen Turner's comments to our monograph *The Geography of Scientific Collaboration* have prompted us to reflect on the issues tackled thereafter with the benefit of hindsight. Two years after the publication, we wonder what issues would have been addressed had we written the book today, especially, would the new perspectives alter the overall tone of our book and the challenges section that we placed at the end of it. Three interrelated matters come upfront in the view of the above: the impact of the COVID-19 pandemic on scientific collaboration, the rise of virtual conferences in scholarly communication and environmental effects of academic mobility.

After the first COVID-19 outbreak in spring 2020, it was indisputable that the pandemic will impact scientific collaboration, at least temporarily. On the one hand, the unprecedented health crisis propelled researchers to join their efforts in, first of all, combating the spread of the virus. On the other hand, widespread lockdowns and mobility restrictions limited or even inhibited any forms of face-to-face con-

tact and thus reduced possibilities of joint research. At the beginning, the pandemic fostered international collaboration in exact science and the greatest development was palpable in COVID-19-related research. In 2020, the share of internationally co-authored articles on COVID-19 was higher than for internationally co-produced papers published before the pandemic and for other papers in 2020, which did not tackle the pandemic (Lee and Haupt 2020). Meanwhile, another study revealed that diversity in international co-authorship was lower in the case of studies related to COVID-19 as opposed to articles with different topics and the pre-pandemic levels (Aviv-Reuven and Rosenfeld 2021). COVID-19 research was conducted in smaller teams and involved researchers from fewer countries than pre-pandemic research of coronaviruses (Fry et al. 2020). In the later stages of the pandemic, the share of domestically authored COVID-19 papers increased and in 2020 as a whole, international collaboration rates for COVID-19 research were in fact at a similar level as those for research altogether (Maher and Van Noorden 2021). These data suggest that with time, scientific nationalism and difficulties related to mobility restrictions gained importance as factors shaping international collaboration in science. International mobility limitations might have been especially harmful for the formation of new collaborations – the process in which face-to-face contacts are vital (Cai, Fry and Wagner 2021). Yet, a study by Liu et al. (2020) identified a 3% increase in new collaborations as compared to the pre-pandemic period. More disciplinary diversity in research teams has been one of the distinctive features of joint research during the pandemic (Cunningham, Smyth and Greene 2021).

Scientific policy instruments pertaining to international collaboration and its geopolitical dimension were imperative in the book. Weakening cooperation between China and the US is an illustrative example of how geopolitics impacted scientific collaboration during COVID-19. The two countries collaborated on COVID-19 papers more than any other pair of countries, and to a larger extent than non-COVID-19 papers (Lee and Haupt 2021). However, as the pandemic continued, tensions between the US and China led to a drop in collaboration rates (Cai, Fry and Wagner 2021). The identified decrease fits into the general slowdown of scientific collaboration between the two countries noticeable since 2017 (Maher and Van Noorden 2021). Due to fear of intellectual-property theft and espionage, the US government started to inspect US researchers who collaborated with Chinese partners more closely. Meanwhile, adopting punitive measures had a 'chilling effect' on establishing new trans-Pacific partnerships (Silver, Tollefson and Gibney 2019). Additionally, visa restrictions imposed by the Trump's administration hampered the research mobility that was already difficult due to the pandemic (Subbaraman and Witze 2020). Ignited by the pandemic surging racial discrimination against the Chinese and American-Chinese community in the US might also carry some weight in this respect. On the other side of the Pacific Ocean, the Chinese government changed the policy of scientific evaluation from promot-

ing quality to valuing the quantity of the papers and recognising not only foreign but also national journals (Mallapaty 2020). In April 2020, a new regulation was introduced, requiring that all Chinese COVID-19 articles must be first centrally reviewed. It reduced the potential for international collaboration and attractiveness of Chinese researchers.

The imposition of travel and congregation restrictions resulting from the COVID-19 pandemic has moved the scientific discussion into virtual spaces (Falk and Hagsten 2021). It was not long until their online versions replaced the initial tendency to suspend academic conferences, seminars, or congresses. A former exception and an option selected only in the event of limited access or environmental capacity became a norm under coercion (Fraser et al., 2017). Some even suggested that "the year 2020 will be known as the year of conference creativity" (Weiniger and Matot 2021). Existing technologies and the scholars' eagerness to adapt worked on a lavish scale. Many conferences have reported increased numbers of delegates who attended online compared to earlier and recent face-to-face events organised by the same association or group (Pearlstein 2020). Nevertheless, the relaxation in mobility and gathering restrictions has not brought back the pre-pandemic traditional patterns of mass academic events organisation (Abbott 2020). For instance, 80% of scholars who responded to a Nature journal survey declared that they would be in favour of some scientific conferences remaining virtual even after the coronavirus pandemic ends (Coronavirus 2020).

Temporary shift to academic meetings online is linked to several advantages that can be analysed through the lenses of their social, scientific, or integrational impact, as online conferences are known for their more inclusive character. Online participation necessitates lower costs, which is convenient for potential participants from lower-income countries or early-stage researchers. Elimination of the need for travel allows for attendance for participants with physical disabilities and those who look after their dependent family members (e.g., children or elderly), which more often pertains to women. When conferences make their proceedings available in the form of recordings, presented scientific findings and achievements have the chance to reach a wider audience, including the general public. Nonetheless, the inclusive character of online conferences may render false. Online format events can replicate inequalities created by face-to-face events and induce alternative forms of exclusion (Levitis et al. 2021). Virtual conferences are still laden with certain costs, and global disparities in capital mentioned by Nico Stehr are hard to overcome. Technical means to attend an online event depend on investment in relevant IT infrastructure and require a stable internet connection with enough bandwidth. Non-negligible are also factors related to time differences among participants, which are minimised during stationary events (Achakulvisut et al. 2021).

In his commentary on our monograph, Stephen Turner encourages us to reflect upon the impact of collaboration organization on the value and quality of scientific achievements. The attempts to assess the value of technology-enhanced conferences versus academic, professional development have been already made (Spilker, Prinsen and Kalz 2020). It is hard to conclude whether the experience of the pandemic can supplement the existing knowledge. The scientific value of virtual conferences is not easy to determine. On the one hand, owing to enhanced inclusiveness, one may expect a positive impact on breaching the dichotomy between the centre and its peripheries which have been imprinted in the existing collaboration patterns. The consequences may include more coverage of topics related to peripheries, diversified participation in international research projects, or out-of-the--box nonstandard research solutions. On the other hand, the same impact is being denoted as cursory and short-lived. Online meetings fail to replicate the social interactions typical for face-to-face meetings; they have minor potential to establish long-term collaboration and strong informal ties among participants conducive to transferring tacit knowledge. Harmful by-products, in this case, include dependence on information and telecommunication technologies or psychological impact like zoom/teams fatigue, as in the sense of tiredness that can arise from continuous or overuse of virtual video-conferencing platforms (Sá, Ferreira and Serpa 2019).

We included issues of online communication in our monograph. We pointed to the presumption that ICT will not significantly influence changes in academic collaboration, which are shaped by a variety of intertwined factors. The pandemic has undoubtedly strengthened the tendency to deploy technology in academic collaboration, and conferences may serve as evidence that such solutions are durable. They can evolve with several implications for the organisation of scholarly collaboration and its spatial dimension. Online conferences have considerable environmental significance (see the below paragraph) can function as an additional argument for their popularisation and permanence (Rissman and Jacobs 2020). Nonetheless, at this point, we should underline that scientific conferences are one of many elements which combined facilitate academic networking. Moreover, systematic literature reviews related to face-to-face conferences indicate research gaps in this respect (Hansen and Pedersen 2018).

Research collaboration is often reflected in researchers' mobility. Scientists' travels are an important factor in establishing and maintaining scientific collaboration. (Although, of course, not all collaboration implies mobility, and not all mobility results in collaboration or takes place within the framework of collaboration). Scientists are one of the most spatially mobile professional groups. Travelling abroad is a regular part of work for a significant number of scholars. Moreover, many studies show positive impacts of international collaboration on the effects of scientific activity and the individual professional development (see: Netz, Hampel and Aman 2020). At the same time, in recent years there have been more and more

concerns translated into scientific publications pointing to negative consequences of scientific mobility for the natural environment (Higham and Font 2020). This is especially true for greenhouse gas emissions from air transport. For scholars globally, plane is the first choice option. Particularly high criticism vilifies the environmental consequences of short-term mobility: participation in conferences, seminars, training courses or project meetings. It is worth emphasising here that the environmental dimension of scientific collaboration is not limited to the environmental footprint of scientific conferences and other forms of mobility in science. Well, virtual conferences also generate a significant environmental footprint (Faber 2021). This way of thinking can be extended further to other aspects of research activity important for collaboration, such as large research infrastructure, which can absorb much energy and generate waste, directly and indirectly damaging the environment. This environmental aspect of scientific collaboration did not echo properly in *The Geography of Scientific Collaboration*. The last part of our book is devoted to policy challenges to be addressed in order to craft smart policies for scientific collaboration. We list eight challenges there. Today we have no doubts that this list should be extended to include the environmental aspect of research collaboration.

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