

But for some disciplines there are no substitutes for international mobility. Since the pandemic, Jonah Choiniere, a palaeontologist at the University of the Witwatersrand, Johannesburg, has had to cancel several trips, including ones to the United Kingdom, the United States and Zimbabwe. Without access to fossils in other countries, he plans to redouble efforts to collect data from universities and museums in South Africa. But it is a partial fix. “I can’t really completely function without international travel – it’s the backbone of my research,” he says.

Many researchers expect that travel for fieldwork will not be affected in the long term. But Choiniere says that the travel freeze – even if it doesn’t last – will affect his productivity two years from now, when the data from his cancelled trips would have been processed. And Sugimoto says that institutions should account for the greater impact of the pandemic on researchers in travel-dependent disciplines when considering whom to promote.

### Virtuous science

But travel restrictions could also help to democratize research, says Choiniere. “Platforms like Zoom talks and virtual scientific meetings level the playing field because they are inexpensive and non-exclusive, and they can result in collaborations quite quickly.”

Last week, when one of his PhD students presented an online lecture about her work on the dinosaur *Massospondylus*, an attendee based in Argentina contacted Choiniere asking to collaborate on projects during lockdown and to pursue more ideas after it ends.

Researchers should consider ways to share data without requiring a physical presence, says Sugimoto. This could help to improve access – both during and after the pandemic – to resources for people who are less mobile because of care responsibilities or disabilities. Fewer flights could make research greener, too. Grounded researchers might begin to re-evaluate their work trips, says Woolley, who used to fly every two weeks. The research community has long grumbled about the climate impact of scientific travel, he says. “COVID-19 has brought an existential health threat into that mix.”

Some travel is necessary for knowledge production, but a lot of it isn’t, he says. “Conducting science responsibly should mean doing your best to reduce greenhouse-gas emissions and not contributing to the spread of a pandemic.”

Researchers might well approach travel with more thought after the pandemic. And that’s no bad thing, says Reid. “It seems unlikely to me that we will be as carefree about travel as we have been in the past.”

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# CHINA’S RACE TO THE TOP HITS A SPEED BUMP

The country is rapidly gaining on the United States in research, but problems threaten to slow its rise.

**W**hen COVID-19 hit, China was close to surpassing the United States as the leading science funder, two years after it took top place as the biggest producer of scientific articles. And the country has boosted science around the world by supplying other regions with graduate students and postdoctoral scholars, who now number in the hundreds of thousands a year.

The pandemic could slow that momentum by shrinking funding for scientific research in China and severely squeezing the pipeline of Chinese students to other countries. And in the United States, researchers fear that the pandemic will exacerbate growing tensions stoked by anti-China rhetoric from President Donald Trump and his administration. This conflict has driven a wedge between the two countries, hampered some collaborations and made the United States less attractive to Chinese students and investigators. At the same time, however, researchers say the pandemic has led many to embrace virtual communication options, and these could enhance international science ties over the long term.

Like all countries, China is facing severe economic losses from the pandemic, and that will certainly have a negative impact on scientific research, because funding will be reduced and projects will be delayed, says physicist Wang Yifang, director of the Institute of High

Energy Physics in Beijing. Some universities have already announced a cut in funding. The research budget given by the education ministry to Jiangnan University in Wuxi, for example, will drop by more than 25% for 2020, and other universities are facing similar reductions. “An overall budget cutting of



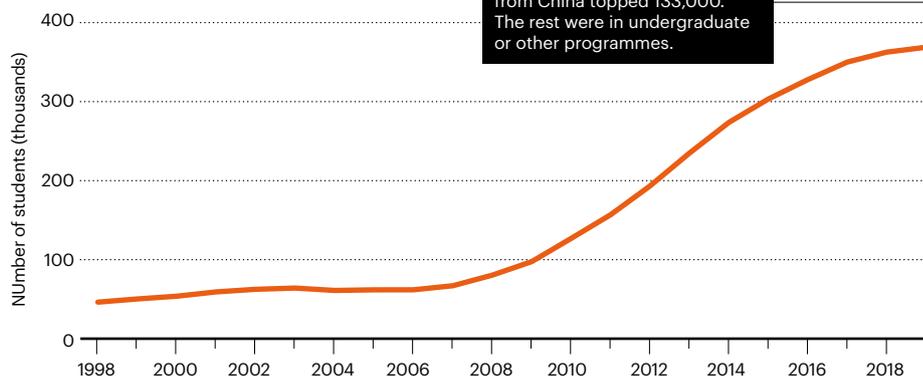
**This is a very positive development, and more companies may follow suit.”**

government spending on higher education is highly possible, though the level and scope may vary by regions, universities and fields,” says Tang Li, a science-policy scientist at Fudan University in Shanghai.

Universities in the United States are particularly vulnerable to a drop in the number of students from China (see ‘Student surge’). Chinese students account for one-third of the nation’s one-million-plus international students at undergraduate and graduate levels, and in 2018, they contributed close to US\$15 billion to the US economy, according to the Institute of International Education in New York. According to a survey by the institute, nearly 90% of US universities expect a drop

### STUDENT SURGE

Universities in the United States have seen a rapid rise in the number of students from China.



In the 2018–19 academic year, the number of graduate students from China topped 133,000. The rest were in undergraduate or other programmes.

SOURCE: OPEN DOORS: REPORT ON INTERNATIONAL EDUCATIONAL EXCHANGE



in international-student enrolment this year. US universities expect the number of international students on campus to decline by 16%, and Chinese students will probably account for the largest share of those decreases.

Although that could harm US science, China would probably suffer, too, says Thomas Scherngell, who researches innovation dynamics at the Austrian Institute of Technology in Vienna. That's because China has gained much more from participation in international research collaborations, driven mostly by sending graduate students abroad, than it has lost owing to a brain drain, he says. Most Chinese students come back to China after their studies, bringing with them highly relevant knowledge. And those who do not come back usually sustain strong connections with their Chinese academic origins in the form of joint research activities, he says.

China was the first country to face the coronavirus outbreak, and it slowed the spread more quickly than did many other countries. Over the next few years, Chinese students might not be able to – or might not want to – travel to countries that have not controlled the virus as well as China has, says Wang. And students might not feel comfortable travelling there while the political atmosphere remains charged. “I hope both barriers will be temporary and the pipeline of students to other countries will not shrink permanently,” he says.

Muming Poo, who heads the Institute of Neuroscience in Shanghai and led a laboratory

at the University of California, Berkeley, for more than a decade, thinks there will be little impact on the number of students going to Europe, but he expects a dramatic drop in those travelling to the United States for graduate studies because of the political tensions. Very few PhD graduates from his institute are applying for postdoctoral positions in the United States, a sharp change from previous years, he says. “The need for students to go abroad for graduate school or postdoctoral research is not as high as that just a decade ago, since the quality of many research laboratories in China is now on a par with those in the best research universities in the West,” he says.

Poo and others say it's not clear whether the changes will linger. Xue Lan, who researches science policy at Tsinghua University in Beijing, says any dampening in the desire to go overseas could be short-lived. “Curiosity is human nature,” says Xue. “Whatever the impact is, it's going to be relatively small,” he says.

Over the long term, the prognosis for science in China is good: the country is soon expected to set an ambitious 2035 goal for the percentage of gross domestic product spent on research, says Cong Cao, a science-policy researcher at the University of Nottingham in Ningbo, China.

The COVID-19 pandemic could help by boosting support from the private sector, which has been relatively scarce in China. Vanke, a property developer based in Shenzhen, recently donated 5.3 billion yuan

(US\$750 million) to Tsinghua University to set up a School of Public Health, initially focused on COVID-19 research. “This is a very positive development, and more companies may follow suit,” says Cao.

Scientists, both inside and outside China, worry about the damage to international collaborations after the pandemic. “This may reshape the landscape of which countries Chinese scholars collaborate with in cutting-edge fields in the future,” says Tang. Richard Suttmeier, a researcher at the University of Oregon in Eugene who specializes in science and technology in US–China relations, warns that “the political conditions for scientific cooperation and educational exchanges are dissipating quickly”. Wang echoes his fears. “COVID-19 may change the world permanently. I am really worried, given the current political mood in Western countries,” says Wang.

But Poo sees reason for hope. The ease of Internet communication and the trend towards holding some international conferences online could maintain robust scientific exchanges and keep Chinese science from becoming isolated, he says. In March, when Poo gave neurobiology lectures online in Chinese, they drew in thousands of students from in and outside China who were able to interact with him. That opportunity left a lasting impression. “I have decided to develop a formal online course in the near future,” he says.

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