

Feature Science after the pandemic

materials through digital platforms is not the best way to teach students. “Zoom university isn’t proper online learning,” he says.

Sarma hopes that when universities resume in-person classes, the experience will be radically different – with instructors distributing video lectures early, and focusing in-person time on interacting with students to ensure that they fully understand concepts. “We don’t want to waste our proximity on one-way stuff,” he says. “It has to be two-way learning.”

Virtual teaching

Some educators expect the pandemic will lead to more and better online teaching than before – in both wealthy countries and those with lower incomes. When universities in Pakistan

“**The pandemic is speeding up changes in a tremendous way.”**

closed in March, many instructors didn’t have the tools to teach online and many students lacked reliable Internet access at home, says Tariq Banuri, chairman of Pakistan’s Higher Education Commission in Islamabad. But the commission has been working to standardize online teaching and to get telecommunication companies to offer students cheaper mobile-broadband packages.

“We’re doing this in context of the virus, but we think these actions will have longer-term benefits,” such as producing students who are better trained for technological jobs, says Banuri. In low- or middle-income countries such as Pakistan, the coronavirus pandemic could force universities to accelerate long-term plans to improve the quality and relevance of their teaching.

All institutions are facing major financial problems, however. Wealthy private US universities, such as Johns Hopkins University in Baltimore, Maryland, expect to lose hundreds of millions of dollars in the next fiscal year. UK universities collectively face a shortfall of at least £2.5 billion (US\$3 billion) in the next year because of projected drops in student enrolment, according to the UK consulting firm London Economics. And Australian universities could shed up to 21,000 full-time jobs this year, including 7,000 in research, a government report said in May.

One of the biggest problems will be the drop in revenue from international students. Australian universities, which rely heavily on tuition fees paid by students from China, expect to lose Aus\$3 billion to \$5 billion (US\$2 billion to \$3 billion), mainly in fees from

international students, says Andrew Norton, who studies higher-education policy at the Australian National University in Canberra. The losses will be concentrated at research-intensive universities such as the University of Sydney, he says, because income from international students often subsidizes research.

The financial shortfall faced by universities around the world might mean that some, especially the smaller ones, will close permanently, says Jenny J. Lee, a higher-education researcher at the University of Arizona in Tucson. Others might merge. And some could develop innovative approaches, such as Arizona’s ‘microcampus’ network. The programme, which has been developed and expanded over the past few years, pairs the university with an institution abroad so that students can take online classes from Arizona and have a local faculty mentor to meet with in-person. “With COVID-19 we’re suddenly realizing what happens when we are physically shut-off from other countries,” Lee says.

Even after the immediate financial crisis passes, the economic outlook could remain bleak. Some researchers say that this might drive universities and funding agencies to focus on research projects and infrastructure that are most relevant to national interests in a post-pandemic world. For instance, the UK government is setting up a research sustainability task force that aims to assess research projects across universities with an eye for planning for the country’s long-term future.

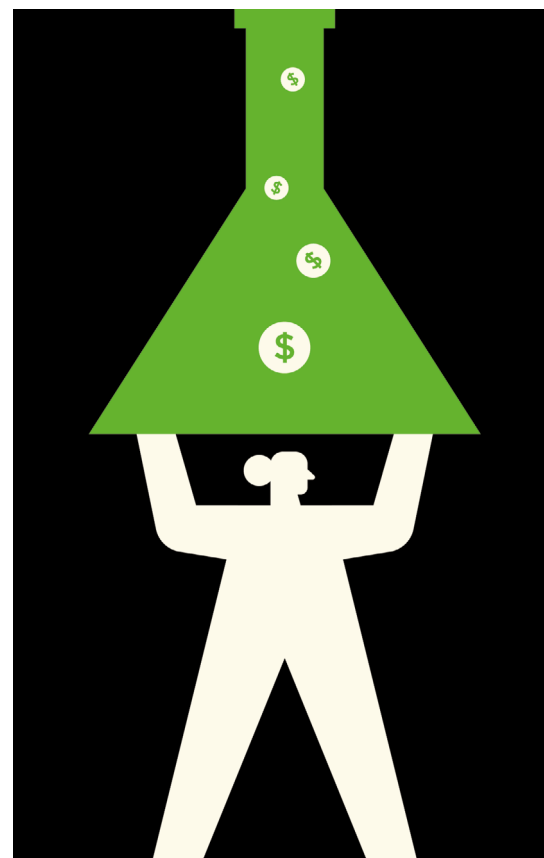
Societal relevance

And the pandemic might help universities push back against the notion that they are elitist and irrelevant to society, a view that populist parties have advanced in the Netherlands, Italy, Spain and elsewhere. Universities in many countries, for example, have led the hunt for ways to treat or prevent COVID-19.

“If a vaccine were to emerge from the United Kingdom, it would emerge from a UK university,” says Nick Hillman, director of the Higher Education Policy Institute in Oxford, UK. Still, Hillman worries that the pandemic might increase disparities between universities if governments route funding into research powerhouses, such as the University of Oxford.

Despite the changes afoot, van der Zwaan doubts that the pandemic will spell the end for most universities. He has been looking into what happened after the Black Death, the fourteenth-century epidemic of bubonic plague that destroyed many aspects of society. Of the roughly 30 universities that existed in Europe at the time, 5 were wiped out. But “after the shock, certain universities came back and thrived”, he says. “This is a really good lesson from the past.”

Alexandra Witze writes for *Nature* from Boulder, Colorado.

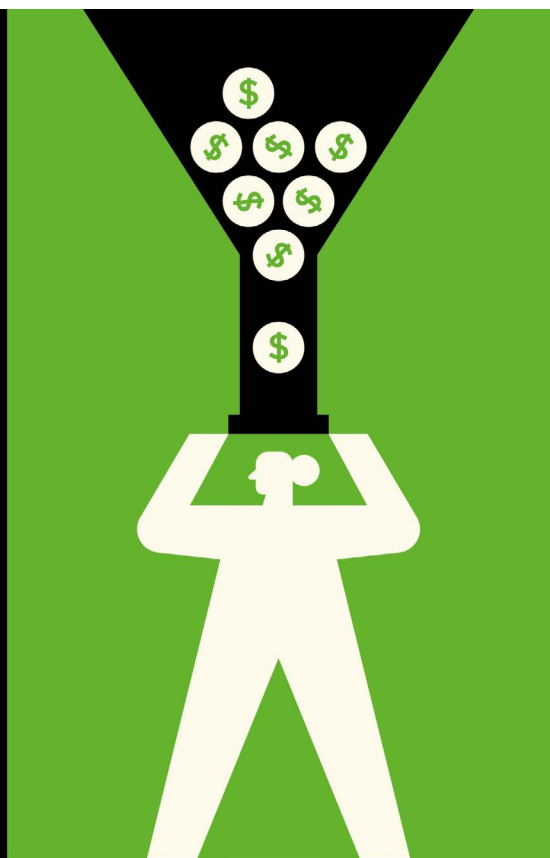


SCIENCE FUNDING FACES POST-PANDEMIC UPHEAVALS

Financial crises could spell trouble for research budgets.

As the pandemic’s economic toll grows around the world, some experts fear it could harm science for decades by putting many thousands of researchers out of work and forcing nations to slash funding as they rebuild societies. Others say the pandemic could highlight the importance of science and spur long-term support, especially for basic research, much as the Second World War did.

In the United States, where the rate of unemployment has risen towards levels last seen during the 1930s, many science leaders are trying to make the case that supporting research and development is crucial. “Without science to help, the country is in jeopardy,”



year, whereas science remains largely intact in Germany, which is committed to investing an additional €17 billion (US\$18 billion) in science agencies through to 2030, at a steady 3% increase in budgets annually. And although China's economy and scientific momentum were slammed by the coronavirus, the country is poised to recover relatively quickly. It's possible there could be a shuffling of priorities, leading the country to invest more in biology and epidemiology, says Cong Cao, a sociologist at the University of Nottingham campus in Ningbo, China.

Some of the most drastic changes could come in the United States, one of the world's largest funders of scientific research and a country where spending decisions are made annually, unlike some other nations.

Several science-policy specialists have been looking to the last economic shock, the recession of 2007–09, for clues to the future. After that downturn, the US government doled out extra money to federal science agencies to jump-start programmes as part of the American Recovery and Reinvestment Act (ARRA), a national plan to boost activity across all sectors (see 'Funding waves'). The NIH, for example, received an extra US\$10.8 billion in 2009 on top of the \$30-billion annual budget. The ARRA fund was "an enormous amount of money" at the time, says Jennifer Zeitzer, director of legislative relations at the Federation of American Societies for Experimental Biology (FASEB), in Bethesda, Maryland.

Big requests

The need this year is expected to eclipse that episode. In early April, a coalition representing US universities asked Congress to provide \$26 billion to science-funding agencies to support the scientific workforce and the reopening of academic labs. The funding could, for example, buffer delayed grants, re-establish colonies of mice that had to be killed and replenish stores of personal protective equipment that were donated to the pandemic effort.

So far, of the roughly \$3 trillion in emergency

money approved by Congress, nearly \$4 billion has been directed at federal science agencies for coronavirus-related work, including developing vaccines and treatments. Groups such as FASEB expect hiring freezes and lab shrinkages to hit early-career faculty members and graduate students particularly hard. "What happens next? Obviously, we're very worried," Zeitzer says.

Even in past economic crises, US science has received steady support from the government and industry, with total funding rising more than tenfold since the 1950s, when adjusted for inflation. The business sector accounts for some 70% of spending on basic, applied and translational research. But the US government remains the country's biggest funder of basic science, making an investment of around \$121 billion in 2017.

Although Congress has steadily increased federal dollars spent on science year-on-year, a big economic shock could trip up that trend. "Then you can see a scenario where in fact, the budgets for research agencies will go down," says Elias Zerhouni, a physician who led the NIH between 2002 and 2008.

Such a blow could tip the balance between basic and applied research. Past budget crunches have favoured experimental and applied science over blue-sky research, says Phillips. And if that happens now, the United States could lose its competitive edge decades later. "The horizon moves in," she says.

But, at a time when the coronavirus response has the attention of the public and lawmakers, this could also be an opportunity for universities and scientists to ask for more, says Varmus. "I think that the country is in a position now to appreciate what science has the potential to offer when the country is challenged. Moreover, they have the ability to recognize the economic consequences of not being better prepared."

In fact, several US lawmakers have introduced legislation to dramatically boost funding for the National Science Foundation. They propose giving the agency \$100 billion over 5 years, compared to its current annual budget of around \$8 billion. The chances of the plan becoming law remain unclear, but Zeitzer expects it would be a smaller amount if it did.

Science in the United Kingdom might fare better than in the United States. In March, the government announced a bold plan to increase research funding from £9 billion (US\$11 billion) a year to £22 billion by 2024–25. So far, there are no signs that commitment will change, says James Wilsdon, who studies science and technology policy at the University of Sheffield, UK. "Clearly, if the overall financial outlook is seriously damaged in terms of a prolonged recession or depression, then all bets are off."

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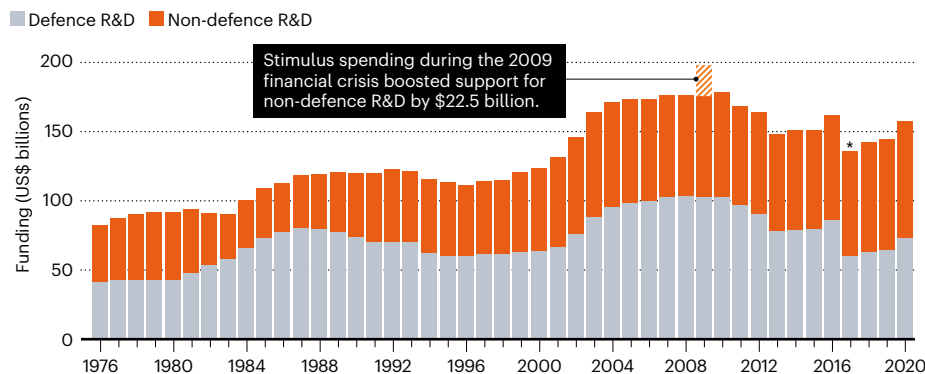
says Harold Varmus, the Nobel-prizewinning cancer scientist who led the US National Institutes of Health (NIH) between 1993 and 1999.

In the wake of the pandemic, the biological sciences might thrive, in the way that the 1957 launch of Sputnik – the beach-ball-sized Soviet satellite that set off the space race – yielded decades of research and discovery in the physical sciences. "Researchers go where the money is," says Julia Phillips, a member of the US National Science Board and former chief technology officer at Sandia National Laboratories in Albuquerque, New Mexico.

The long-term economic consequences for science will vary significantly by country. Australia, for example, has warned that 7,000 university research jobs are at risk this

FUNDING WAVES

Spending by the US federal government on research and development (R&D) has risen unevenly over the decades, with more variation in defence-related work.



*US agencies redefined some categories of projects in 2017 so that they are no longer R&D.