
WHAT PRICE WILL SCIENCE PAY FOR AUSTERITY?

*Japan's stagnated research output
corresponds with a deteriorating situation
for young researchers*

BY ICHIKO FUYUNO

Scientists at Hokkaido University had much to celebrate in 2016. Cancer researchers identified a possible target to thwart chemotherapy-resistant tumour cells, while a telescope jointly developed by Hokkaido University arrived at the International Space Station to take high-resolution images of Earth.

But, behind the success stories, scientists at the prestigious university in the country's north are worried. To meet budget constraints, university management last year proposed reducing staff costs by almost 15% over five years — the equivalent of cutting about 205 professor-level positions. After vociferous opposition by faculty and the staff union, the university's incoming president Toyoharu Nawa has proposed to shave only 7.5% off the staff budget. Nawa says the university will try to retain as many tenure positions as possible by cutting spending in other areas, while seeking more external funding to hire more contract-based researchers.

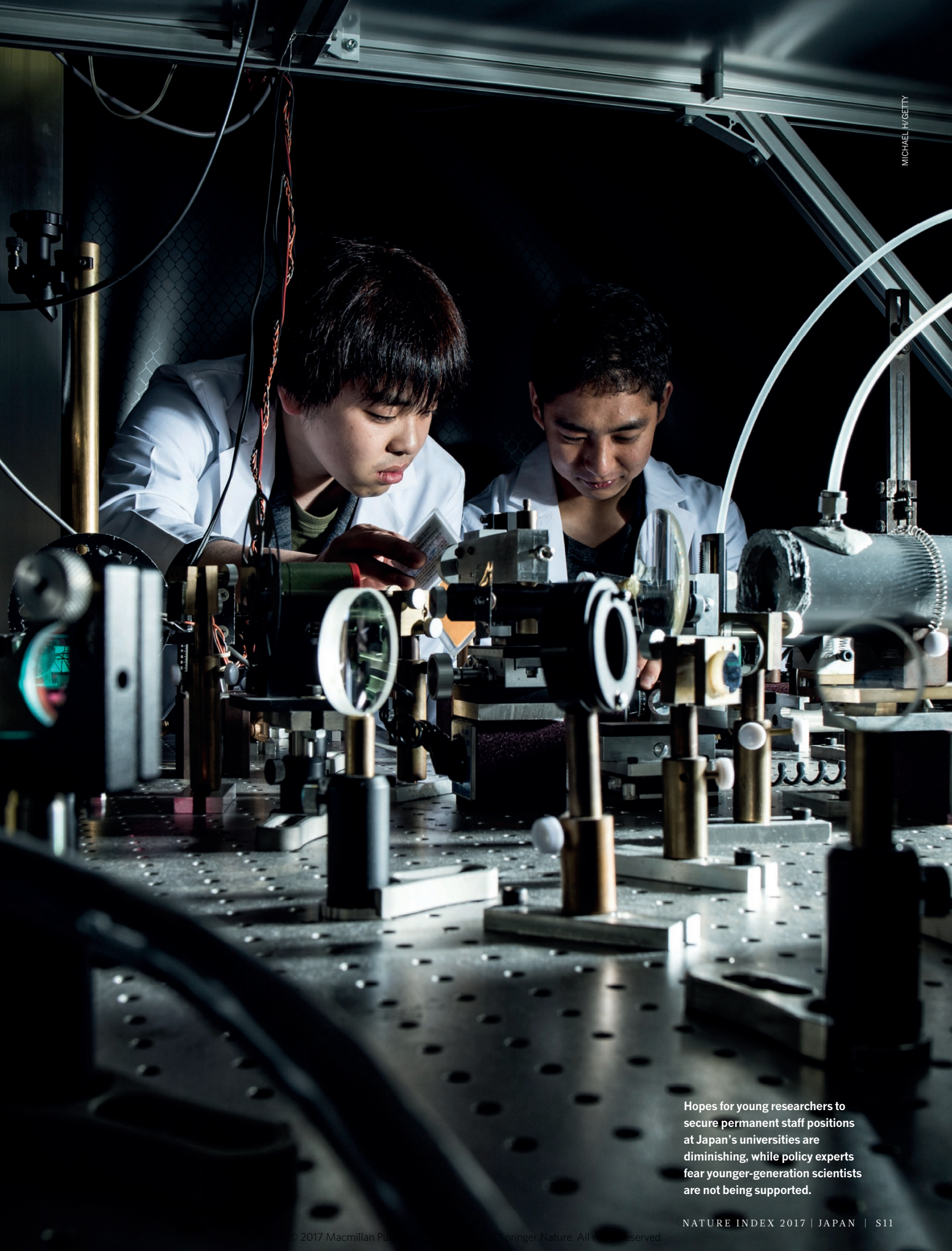
These positions will make young researchers more mobile and stimulate interdisciplinary collaboration, which will ultimately strengthen

research capability, Nawa says. "We understand people are our most important asset."

But chief secretary of the union, Shigeru Mitsumoto, says any cuts will have a significant impact on early-career researchers seeking a full-time job to focus on their work, and so jeopardize the country's scientific potential. "If a research-oriented university like us can't offer them opportunities, Japan will have no future," he says.

The situation at Hokkaido University is not unique. Across Japan, early-career researchers face an uncertain future, as universities reduce the number of permanent staff positions and shunt more faculty into short-term contracts. There is little hope for immediate improvement in employment opportunities for young researchers, according to Takayuki Hayashi, who investigates science policies at the National Institution for Academic Degrees and Quality Enhancement of Higher Education.

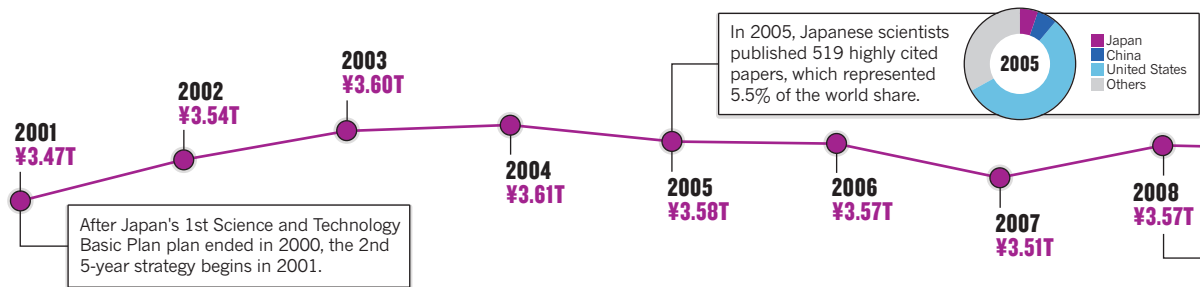
Over the past decade, Japan's research output has struggled to keep up with the world's leading science nations, a situation some policy experts believe has been exacerbated by a failure to support the next generation of scientists.



Hopes for young researchers to secure permanent staff positions at Japan's universities are diminishing, while policy experts fear younger-generation scientists are not being supported.

SCIENCE SPENDING

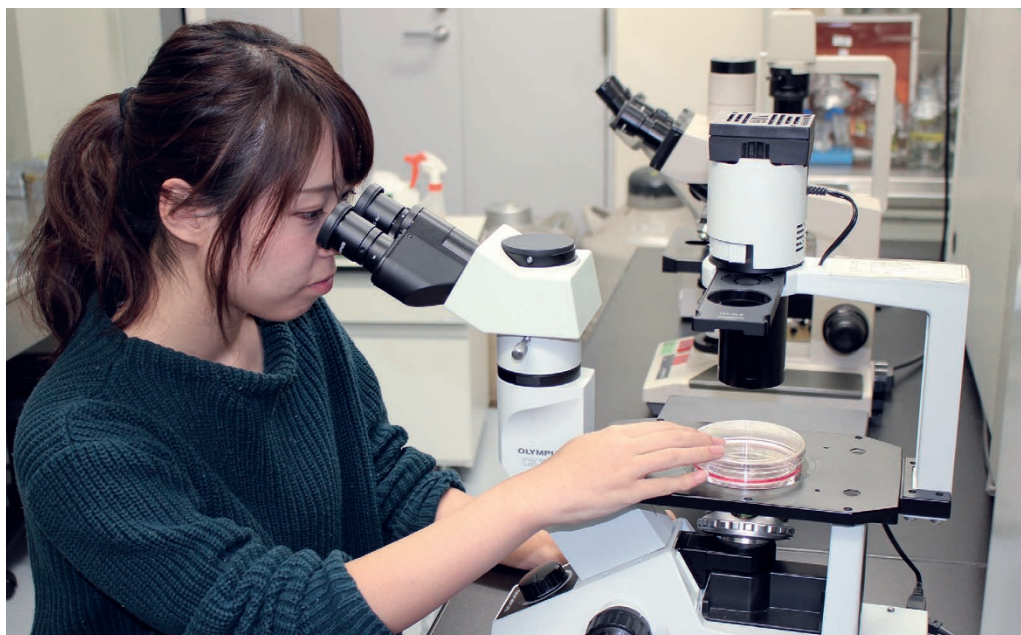
The government's science and technology budget has remained fairly flat since 2001.



UNINTENDED CONSEQUENCES

Several factors have contributed to Japan's current situation. The economy has been slow to recover from its collapse in the early 1990s. While Japan's spending on research and development as a share of GDP is among the world's highest (topped only by South Korea and Israel), the government's budget for science and technology has essentially remained flat since 2001. Meanwhile, other leading research nations such as Germany, South Korea and China have significantly increased their spending.

Since the early 2000s, the Japanese government has reduced the funding for universities to pay staff salaries, including cutting the management expenses grant programme by about 1% a year between 2004 and 2014. As a result, more than a third (33) of national universities have not filled tenure positions after professors retire, and have stopped hiring new staff or placed researchers on contracts, according to the Japan Association of National Universities. The World Premier International Research Center Initiative (WPI)'s International Center for Materials Nanoarchitectonics (MANA) in Tsukuba, for example, plans to eliminate 30 of its 70 postdoctoral positions during 2017.



Nagisa Nishiyama studies cell differentiation under Satoshi Tanaka at Okayama University.

A government policy, introduced in the 1990s, to produce 10,000 post-doctoral researchers to strengthen the country's competitiveness, may be compounding problems. While the government intended for many of these researchers to work in the private sector, an unintended consequence is that a large portion stayed in academia. By 2012, the number of postdocs had surged past the government's target — more than 16,000 in academia. The problem is most acute in life sciences, in which the government invested heavily in the early 2000s. As a result, postdocs often hop from one position to another waiting for an offer of an increasingly rare permanent research position.

"Money is not the priority for young researchers," says Eijiro Sumii, who studies programming language theory at Tohoku

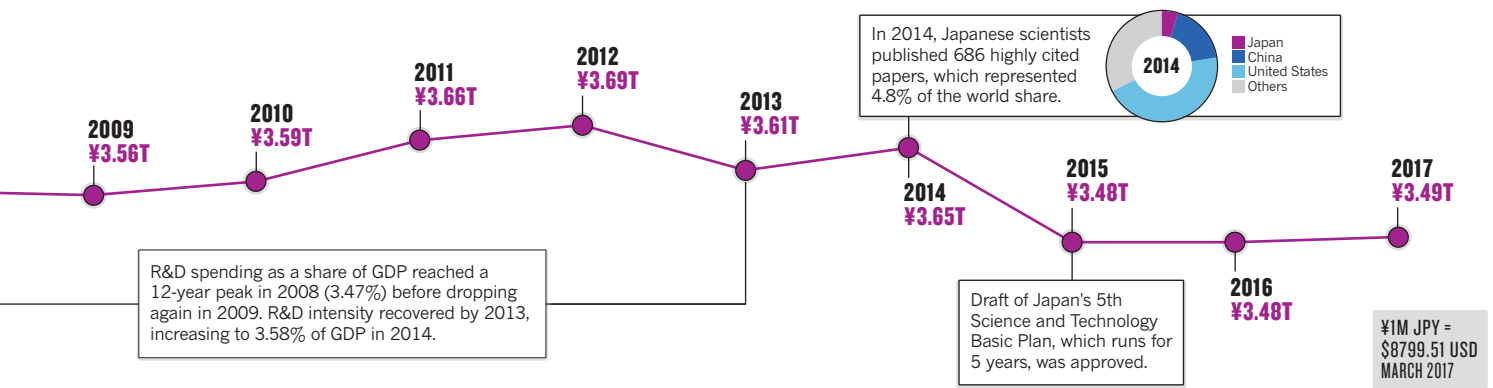
University and is the secretary of the Young Academy of the Science Council of Japan. "They just want more time to concentrate on research but they have to spend a lot of time writing job application forms and documents to report to the government."

One researcher on a short-term contract, who asked not to be named, said despite being an experienced research associate in his 30s, he had to do the menial chores in his lab, such as checking samples and disposing of waste after experiments, because his university could not afford technicians. "In the US, even postdocs won't do that," he says.

Scientists fear students are being dissuaded from a research career. "I am no longer able to say to students that a career as a scientist would be great," says Satoshi Tanaka, a biochemist at Okayama University. Despite the

THE NUMBER OF RESEARCH ASSOCIATES UNDER 40 AND ON CONTRACTS MORE THAN DOUBLED BETWEEN 2007 AND 2013.

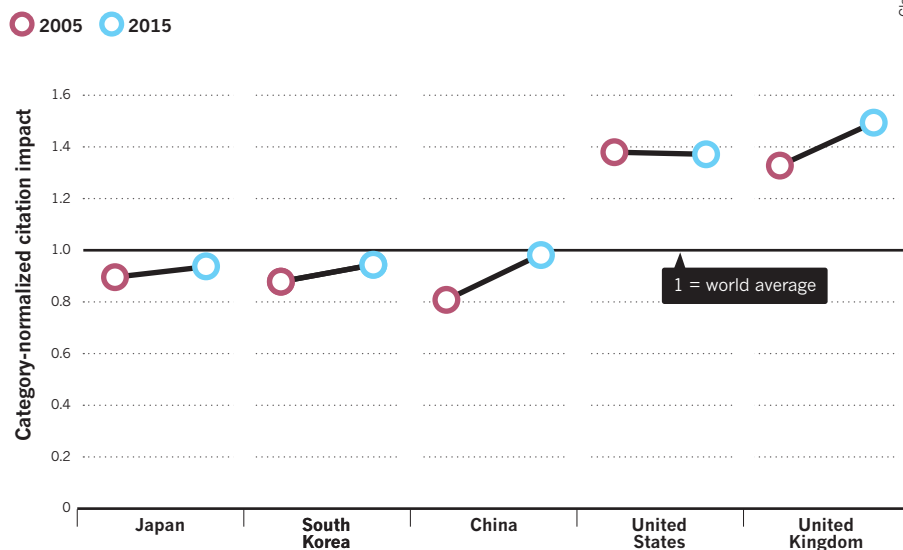
National Institute of Science and Technology Policy



Sources: Cabinet Office, Government of Japan; Clarivate Analytics; UNESCO.

THE GOOD NEWS

The average citation impact of the country's scholarly output has increased slightly, but not as much as China and South Korea.



Source: Clarivate Analytics

a similar trend. Between 2005 and 2015, the number of Japanese papers declined in 11 out of 14 research fields. Indeed, the country's global share of papers in Scopus fell by more than a third over ten years, due largely to strong growth by China and South Korea.

Japan's government has introduced several programmes to lift the country's top research institutions to among the world's best. This has meant concentrating its investments on people and institutions with a proven track record seen to have a better chance of increasing the country's global competitiveness. The top five institutions of the country's 86 national universities received almost half of the more than ¥100 billion (about USD\$900 million) to be invested by the country's largest competitive research grant program this year.

Takuya Saito, director of the Office for Basic Research Programs at the Ministry of Education, Culture, Sports, Science and Technology (MEXT), says programmes such as the (WPI) and the PRESTO (Precursory Research for Embryonic Science and Technology) grant are producing globally competitive researchers.

But, he admits these are a small number of people, and that the government's efforts aren't enough to improve the situation for young researchers in Japan.

Initial signs that the situation may be improving for early- and mid-career researchers have emerged. The government plans to increase by 10% the number of university researchers under 40 by 2020, partly by supporting initiatives that offer more tenure or tenure-track positions, and allowing more flexible use of funding to hire researchers.

From April, the country's premier research institution, RIKEN, will start replacing some contracts with tenure positions. Over the next seven years, the institute intends to increase the portion of its total staff that is tenured from 10% to 40%. These new positions won't offer the same retirement package, but researchers will have better job security. ■

glut of postdoctoral researchers the number of students entering doctoral courses has been falling since its peak in 2003. While this may arrest the oversupply of postdocs, a continual decline in the number of PhD students could leave a gap in Japan's future scientific capacity.

Meanwhile, the existing research workforce is ageing, common across all sectors in the country with the world's oldest population. From 2004 to 2013, the number of researchers under 40 fell 11%; during that same period, the total number of researchers, excluding post-doctoral researchers, at national universities rose 2%. Since the early 2000s, many universities have also raised the retirement age from 60 to 65, reducing the number of permanent positions for younger scientists.

Hiroshi Nagano, a visiting fellow at the Japan Science and Technology Agency and

an expert in the science policies of Japan and Europe, says Japan doesn't encourage young researchers to become principal investigators at an early stage of their career. This failure to adequately foster up-and-coming researchers "is one of the major causes of the continuous deterioration of our country's scientific performance," says Nagano.

STAGNATED PERFORMANCE

In the past five years, Japan's overall scientific output has not kept pace with the growth of its neighbours, particularly China and South Korea (see page S14). The number of articles produced by Japanese authors in the Nature Index fell 8.3% between 2012 and 2016. During that same period, the United Kingdom's output rose 17.3% and China's shot up 47.7%.

The Web of Science (WoS) database reveals

Japan by numbers

Japan is one of the world's top research-producing nations. But, over the past decade its scholarly output has not kept pace with the average growth in publications around the world. While the total number of articles in Scopus increased by about 80% between 2005 and 2015, Japan's output grew by a mere 14%.

Japan's global share declined by more than a third over the decade, while China experienced extraordinary growth. Data from the WoS follow a similar trend.

Anders Karlsson, vice president, academic relations at Elsevier, said although Japan had an excellent research pedigree, with 17 Nobel Prizes in the sciences awarded since 2000, the country's declining population, meaning fewer researchers, and flat research investment were affecting its performance. "Japan has declined in its global share and thus in global impact," says Karlsson.

The significant rise in papers from countries such as China and South Korea meant nations with a well-established research landscape were losing their share of global output, said David Pendlebury, an analyst with Clarivate Analytics.

Japan lagged behind the average global output in 13 of 14 fields, according to data from the WoS. Astronomy was the only field in which it outperformed the average.

"Japan is a special case, because in absolute terms, it's not growing either," said Pendlebury. In 11 fields, Japan published fewer articles in 2015 than in 2005, he said. In materials science and engineering, strong areas for Japan historically, its publications fell by more than 10%. The most acute declines were in biochemistry/molecular biology, computer science and, a traditionally strong area for Japan, immunology. In only three fields, medicine, mathematics and astronomy, did Japan publish more papers in 2015 than in 2005.

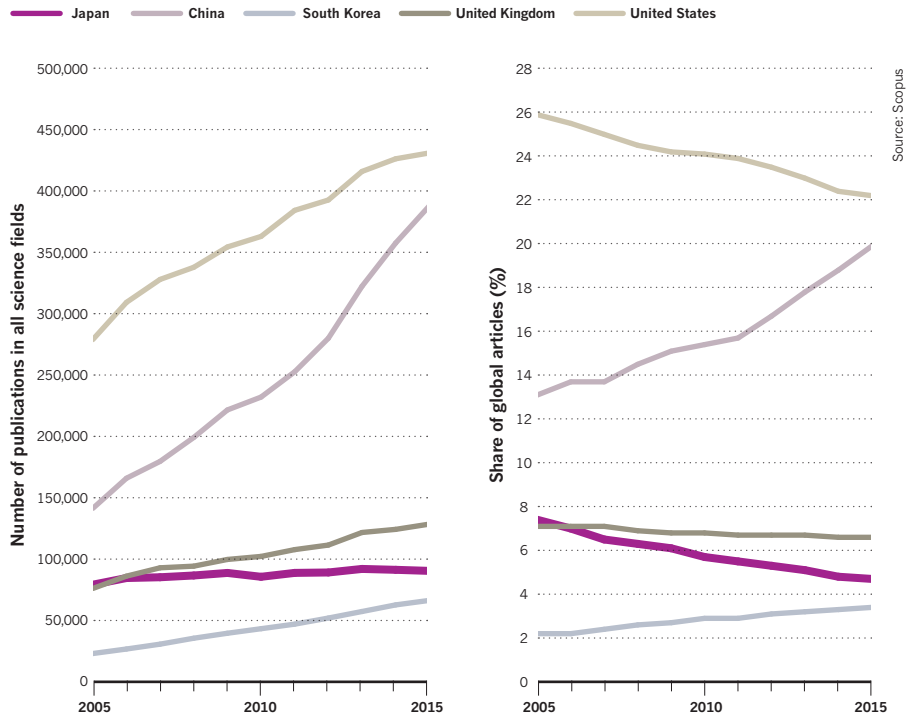
Though the statistics are damning, Pendlebury acknowledges that Japan still has many world-class scientists.

Karlsson said the country has introduced some positive reforms, such as universities being more strategic, and national programs to facilitate knowledge transfer and recruit international researchers. But, he asked, "is the transformation radical enough?" ■

DATA ANALYSIS BY LARISSA KOGLECK, AARON BALLAGH, DAVID PENDLEBURY (CLARIVATE ANALYTICS) AND ANDERS KARLSSON (ELSEVIER)

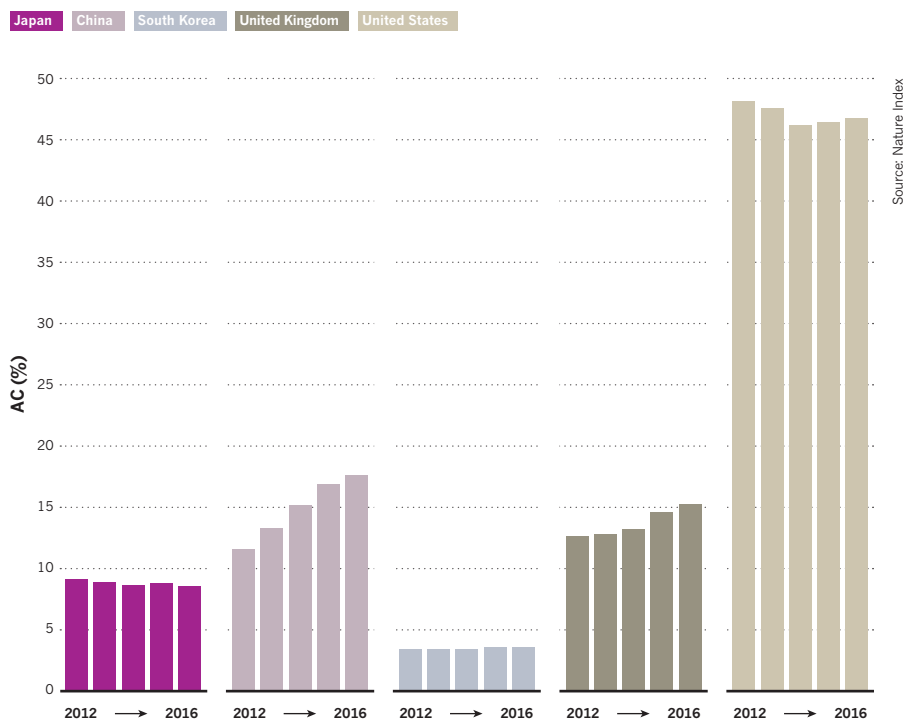
TOTAL OUTPUT

Japan's number of articles in Scopus increased slightly between 2005 and 2015, but its share of articles dropped over the past decade unlike its rivals, South Korea and China.



HIGH-QUALITY OUTPUT

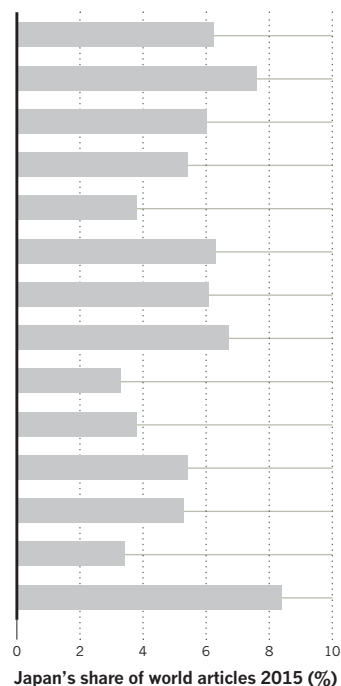
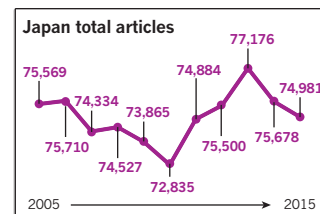
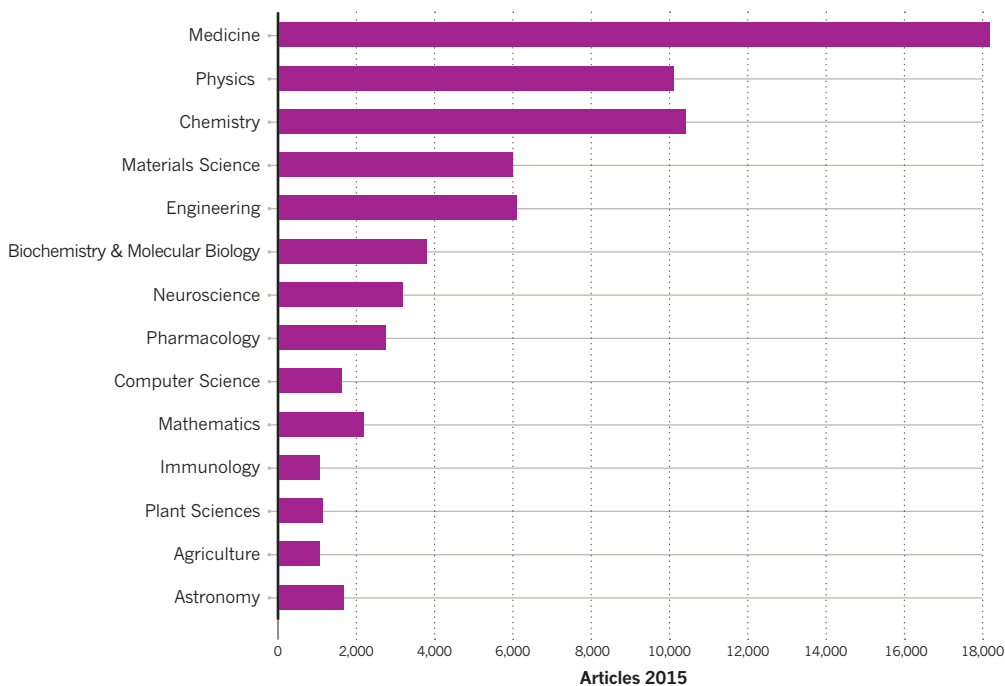
Japan's share of high-quality papers (AC) included in the Nature Index dropped between 2012 and 2016, as did the United States' share. China and the United Kingdom's share of articles grew over that time.



SUBJECT OUTPUTS

Japan's number of articles, and share of global articles, by field in the Web of Science in 2015. The country's total number of articles in WoS between 2005 and 2015 (right).

Japan articles Japan's share of world AC (%)

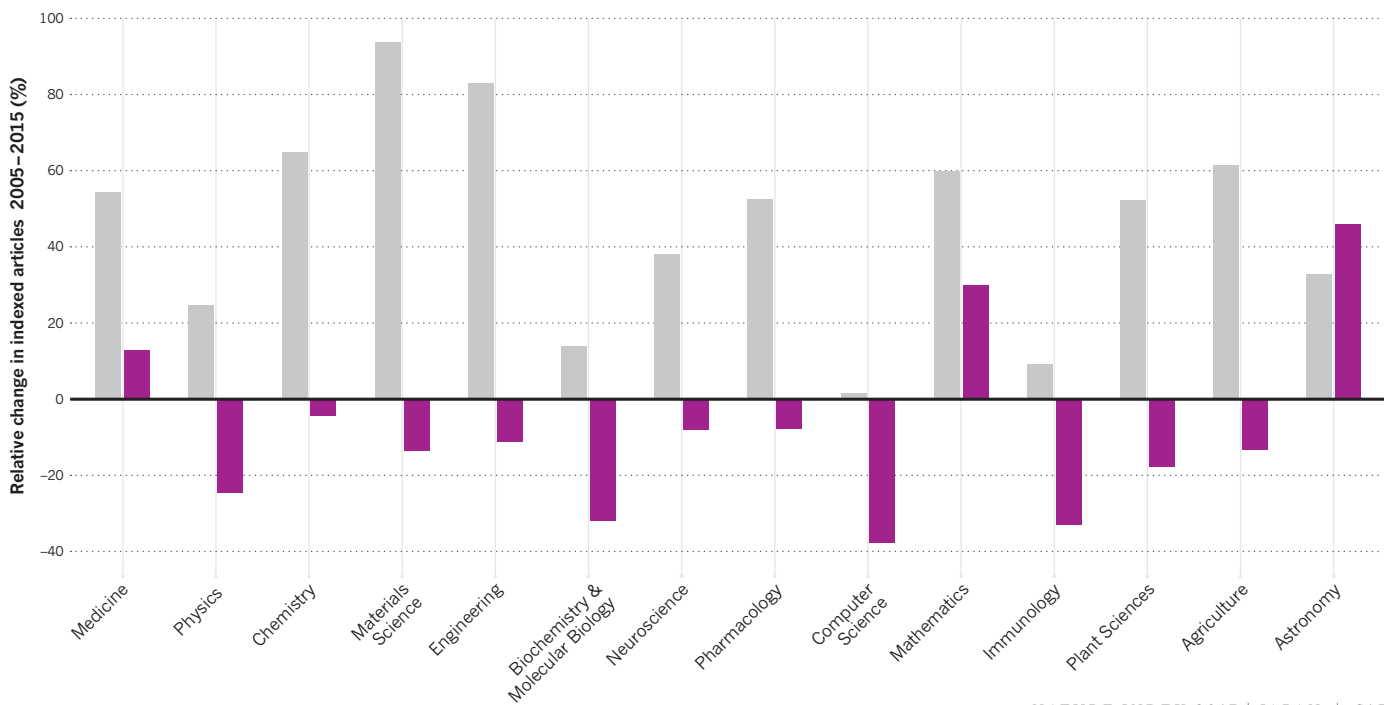


Source: Web of Science

JAPAN VS THE WORLD

While the number of publications indexed in the Web of Science has increased in all fields between 2005 and 2015, Japan has not kept pace with the rest of the world. In most fields Japan produced fewer articles in 2015 than in 2005.

Japan Rest of world



Source: Web of Science