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Cell

Biology Boom Goes Bust

Political and industrial factors—beyond the economic headwinds—may be causing public investment in biomedical research to slow down around the world.

It was 10 years ago that the US National Institutes of Health (NIH)—the largest research agency in the world—completed an incredible 5 year project to double its budget.

The doubling took the NIH annual budget from $13.6 billion in 1998 to $27.1 billion in 2003, sparked a visible building boom at medical research centers in most major US cities, and sucked in graduate students, postdocs, and researchers from every corner of the globe.

But now, biomedical research funding is falling back to Earth with a bump. Total public spending on research and development by the US federal government has fallen for 4 years in a row (see chart). "These are absolutely the biggest cuts we've seen in recent times," says Mark Hourihan, director of the R&D Budget and Policy Program at the American Association for the Advancement of Science.

Uncomfortably for life scientists, the cuts in biomedical research have been even steeper than in other disciplines. And rather than being some kind of aberration, the US pattern is being reflected elsewhere. Of the world's established scientific powers, only Germany is consistently increasing its spending (see map).

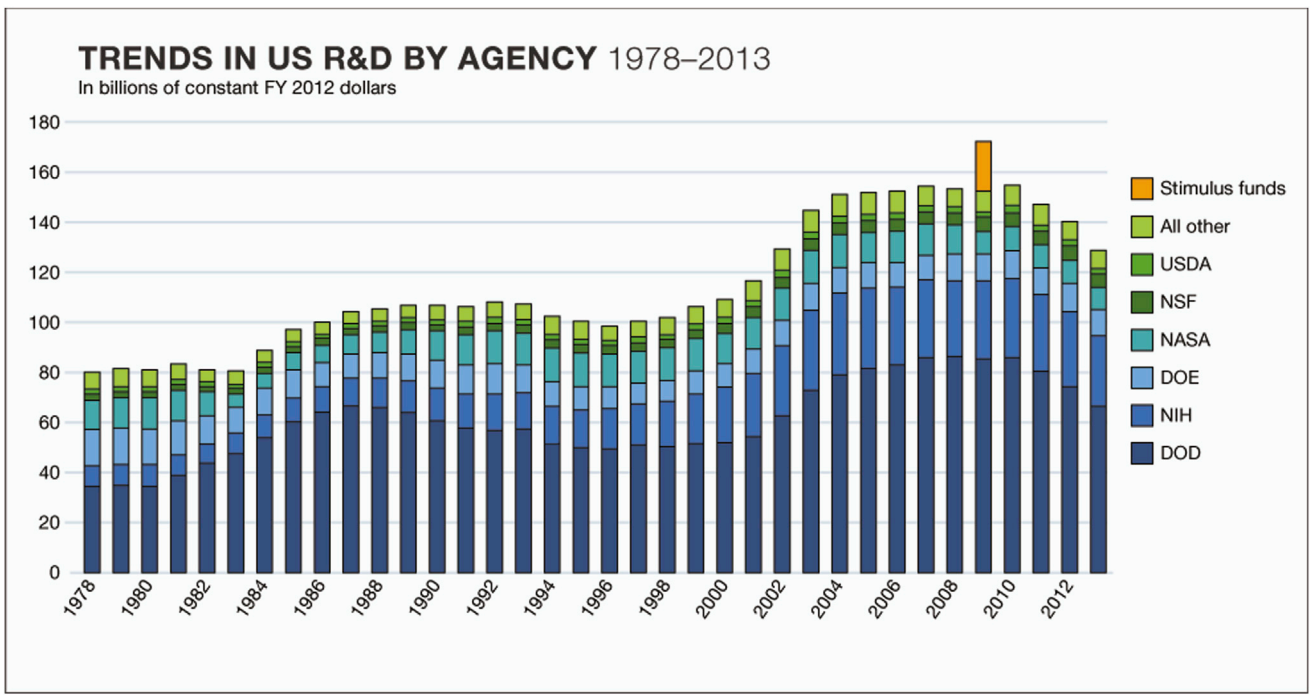
Among the emerging powers, China and South Korea are also doing so—and their progress is stirring up the global circulation of students and ideas. But, although these two nation's fresh investment is significant, it is not commensurate with the drop in spending elsewhere.

The budget of the NIH—aided by a $10 billion blast of stimulus funds—reached about $35 billion in 2010. It has fallen back since, as the stimulus fades. And, this year, after the unexpected passage of an across-the-board spending cut known as "sequestration," it will fall by another $1.5 billion to $29.3 billion.

"This is a very serious blow that we'd hoped to avoid," says Francis Collins, a geneticist and director of NIH. "About three-quarters of the budget is already committed, so a blow like this could fall heavily on new proposals. That is particularly worrying, as these represent our future."

To try to relieve the impact of sequestration, several NIH institutes are shaving 5% of funds that they had already pledged to commit this year, Collins says. He adds that the NIH will be "looking to trim back" the typical annual value of a NIH's main funding mechanism, the RO1 grant.

Collins says he is acutely aware of the customary hazard that, when funds recede, experienced grant getters win out at the expense of young people with new ideas. "I am very concerned about that, as are all 27 institute directors," he says, pledging to back schemes such as the agency's New Innovator Awards "to provide an antidote to the conservative response" that can arise from funding cuts.



Adapted from appropriations progress charts by the American Association for the Advancement of Science.

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At US universities and medical schools, the March implementation of the sequestration came as a nasty surprise, despite the prolonged and noisy political debate that preceded it. Jim Siedow, a plant biologist and vice provost for research at Duke University in North Carolina, says that the implications of the cut will become clearer later in the year, as it eats away at envisaged income.

"We're very worried about people losing their grants," says Siedow, noting that, with most university costs being fixed, "it is in personnel—postdocs and research technicians—that savings will have to be made." He fears the climate will continue to worsen after this year. "There's talk of the NIH budget five years from now being 25% less than it is now," he says. At Duke, he adds, "we haven't had to make big nasty decisions—yet."

The other major scientific nations of the English-speaking world—Canada, Australia, and the United Kingdom—each implemented expansions in biomedical research funding of their own soon after the NIH doubling. In each case, 2013 budgets confirm that this expansion has now ended.

Of the main biomedical research agencies in the three nations, the UK Medical Research Council is probably in the best shape. Spending there will increase this year by 3%, in line with a 3 year plan that allows the agency's budget to grow with inflation.

In Canada, a March budget allocated an extra C$160 million to Genome Canada over 3 years, as well as C$220 million for research infrastructure. But overall spending at the Canadian Institutes of Health Research (CIHR) will fall by 3%. "The focus is to deal with the deficit and throw research a few bones," says Paul Dufour, a long-time adviser on Canadian research policy based in Quebec.

Australia's economy, like Canada's, has performed relatively well since 2008, but even so, research there has fallen victim to austerity. Although Warwick Anderson, a physiologist and chief executive of the National Health and Medical Research Council, says that its 2013 budget is "basically in steady state," he admits that this "has come as a bit of a surprise; people had been used to growth."

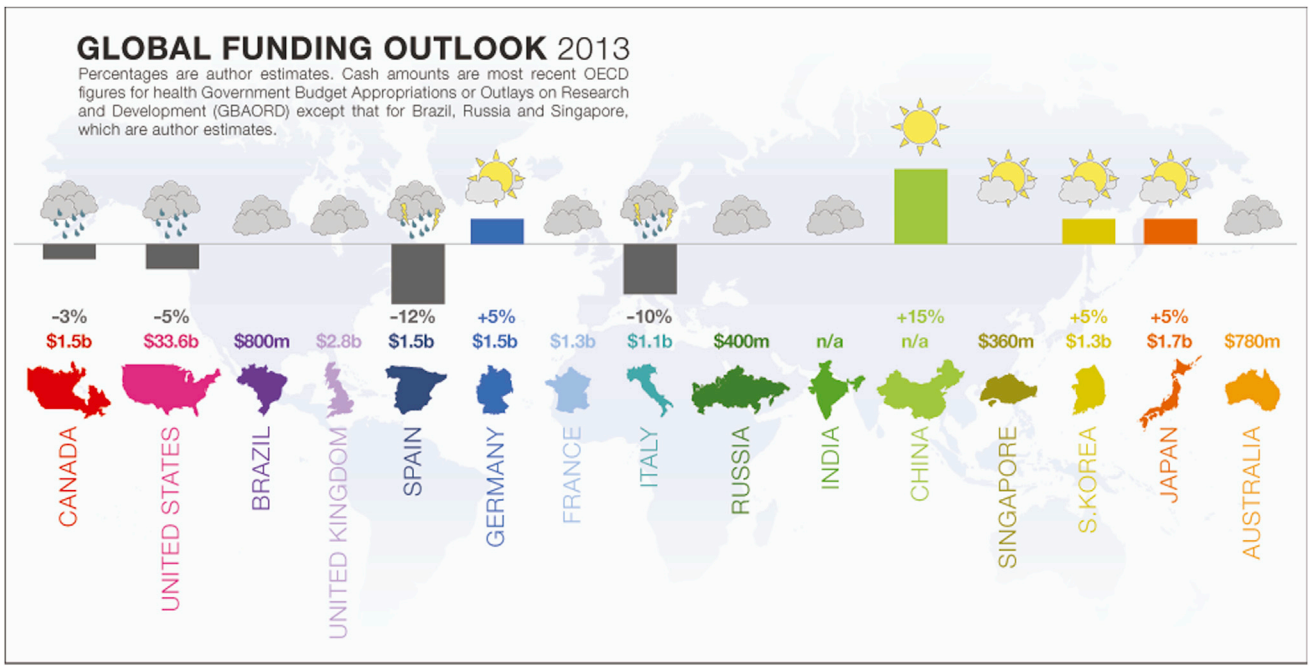
But Australian universities complain that last October's midyear budget whisked away some A$500 million in overhead payments that they had been planning for over the next 4 years and that inflation is also eating into the value of grants. "There's been a steady chipping away of what's available," says Brendan Crabb, a microbiologist and president of the Association of Australian Medical Research Institutes (AAMRI).

Such erosion is small beer, however, compared with the turmoil in the countries whose economies have been hardest hit by the financial crisis. Since 2008, Italy and Spain have both experienced rocky descents that have taken away about 40% of their research funding, according to local campaigners. In neither case do official budget figures tell the full story. In Spain, for example, it emerged last September that up to half of the national research budget, allocated as "loans" for companies or research institutes, hadn't been getting spent at all.

"This has been going on for a long time, and the situation is now unsustainable," says Amaya Moro-Martin, an astrobiologist at the Spanish Research Council in Madrid. "They are dismantling the entire scientific infrastructure of the country."

Moro-Martin helped found a grassroots action group, Investigación Digna (Dignify Research), whose open protest letter to the government has attracted 28,000 signatures. A similar group, Return on Academic Research (ROAR), is active in Italy. There has been little sign, however, that these scientist-activists are having an impact on policy.

France, meanwhile, has had its share of economic problems, and last October's



budget granted increases of about 2%—about the same as the rate of inflation—to most research agencies.

"The situation we're facing is difficult," says Antione Triller, a cell biologist at Ecole Normale Superieure in Paris, noting that the success rate for grants at ANR, France's main grants agency, is down to 13%. Successive governments have sought to pull away from the traditional French model—whereby most researchers hold secure positions at laboratories run by government agencies such as CNRS—and introduce more competitive grants, as in the US and UK. Now that budgets are falling everywhere, the security offered by the old system has its advantages, Triller says: "In a way, in a crisis situation, the French system is not so bad."

For the third year in a row, Germany is the only large European nation to substantially increase science spending. In March's budget, funding for the Federal Ministry of Education and Research (BMBF) was up 6.3% to €13.75 billion. Biomedical research will grow somewhat less than that; a BMBF spokeswoman said it didn't have a precise figure due to "restructuring." This is a slowdown from 9% growth last year and 11% in 2011. With an election looming and the economy slowing, German scientists worry that their recent spurt of funding growth is coming to an end.

After the West's economy hit the buffers in 2008, research funding in the developing countries, at least, continued to expand. But, of the large, emerging powers—Brazil, Russia, India, and China—only the last seems determined to keep that expansion going.

There is, nonetheless, a rebalancing taking place in the flow of researchers between the "developed" and "developing" nations. In 2006, for example, Foundation for Research Support of the State of São Paulo (FAPESP)—the largest research funding agency in South America, serving Brazil's São Paulo state—started a program to attract foreign postdocs. That year, it had hired just two postdocs from the US, five from Italy, and none from the UK. Last year, according to scientific director Carlos Henrique de Brito Cruz, it took on 19 from the United States, 14 from Italy, and 9 from Britain.

"There are three things going on here," Brito observes. "Brazil is becoming a more interesting address for a scientist. FAPESP created a program to hire them. And funding in the developed countries became more difficult."

Even Russia, where science has struggled to recover its footing ever since the collapse of the Soviet Union, has made some headway in addressing this balance, awarding "megagrants" worth about $5 million each to a handful of principal investigators, many of them returning from positions abroad.

New institutions such as Skoltech, an ambitious collaboration between a government-endowed foundation and the Massachusetts Institutes of Technology to build a postgraduate university outside Moscow, are also starting to challenge the Russian Academy of Sciences as centers of influence in Russian science.

In February 2012, India released a national 5 year plan that promised to sharply ramp up the budgets of the two main health research agencies, the Department of Biotechnology and the Indian Council of Medical Research. However, the Indian economy has slowed since then; budget increases pledged last year were not implemented, and Indian scientists now say they expect none this year either.

Only in the Far East is the funding outlook brighter. After a decade of stagnant funding, Japanese spending picked up last year, and the government announced a "stimulus package" in January that will pour $11 billion into science and technology, including $240 million specifically for stem cell research and larger amounts across all disciplines for infrastructure ($960 million) and industry-university collaboration ($2 billion). It isn't known how much of that will go to biomedical research or how long it will take to spend; the money was disbursed by March, but the actual expenditure will run over 2 years or perhaps more.

Singapore's Biomedical Research Council has assured funding of S$ 2.4 billion over the 2011–2015 period. Its recent effort to work with industry has drawn in S$ 75 million of additional support from companies over the last 2 years, says Benjamin Seet, the council's executive director, noting the recent establishment of laboratories by L'Oréal and Procter & Gamble on the island. "Biomedical research has increasing relevance beyond the pharmaceutical industry," he says.

South Korea has often posted double-digit increases in its research spending in recent years. But this slowed to just 5% in 2012, according to revised government figures and will be lucky to match that this year.

It is China that continues to pour new resources into research at a rate truly significant on a global scale.

Last year, it surpassed Japan as the second-largest global power in research and development, spending an estimated $160 billion last year. The great bulk of this, however, is for product development in the manufacturing industry. Most of China's best science is in disciplines directly supporting that, such as materials science.

China's investment in biomedical research—which is coming from cities and states, as well as from national agencies in Beijing—has not been reliably estimated. The Organization for Economic Cooperation and Development (OECD) reports that total Chinese government investment in research and development was $6.9 billion in 2011 and had been growing at an extraordinary compound rate of 20% since 2003.

But, in the absence of reliable budget data, there is plenty of other evidence that China is emerging as a real power in biomedical science. According to data published in January by the Nature Publishing Group, for example, Chinese publication in the group's journals (which are heavily weighted toward the life sciences) grew 4-fold between 2008 and 2012. China comfortably surpassed Australia and is closing in on Japan as the largest scientific power in the Asia-Pacific region.

China's emergence is, however, a bright spot in a darkening picture for global biomedical research. When this informal survey started in *Cell* 2 years ago, almost all of those interviewed attributed any slowdown in spending to the weak, short-term economic outlook.

It is now clear that some additional forces are coming into play. One is the retrenchment in the pharmaceutical industry, which is struggling to fill its drug pipeline and has been closing down major research laboratories. A second—possibly related—factor may be diminishing political faith in biomedical research

as a route to better and cheaper healthcare.

The drug industry announced thousands of layoffs last year, notably in Australia, Canada, and the UK—countries whose governments had set great store in backing biomedical research. ''There's been a massive restructuring of the industry worldwide,'' says Mark Downs, chief executive of the Society of Biology in London, noting how drug companies are now turning to universities and small biotechnology companies for their future product development. ''The jury is still out on whether the new model will work.''

This change has been accompanied—at least in the US—by adverse developments in the politics of biomedical research. When Congress began to double the NIH budget in 1998, the House and Senate were dominated by ''barons'' such as Senator Mark Hatfield (Republican, Oregon) and Senator Robert Byrd (Democrat, West Virginia), who feared disease themselves and set great store by the NIH's ability to fight it. Just one of them—Pennsylvania senator Arlen Specter—single-handedly maneuvered a cool $10 billion for NIH into President Obama's 2009 stimulus package.

Now these men have retired or died to be replaced by congressional leaders who have no particular attachment to medical research. Francis Collins says that his agency is looking out for allies. ''We have supporters in both Houses of Congress. Much of this will hang on what leadership of the country can achieve, to put budgetary decision-making on a more rational basis,'' he says. ''But we're also fortunate that biomedical research continues to be one of the few issues that is not intrinsically partisan.''

Even so, US university administrators worry about where NIH will find congressional support in the future. ''There's a limited number who've expressed an interest,'' says Duke's Jim Siedow. ''For some reason, the NIH has lost some of its luster. They don't think that it handled the doubling very well.''

It was the US Congress that started the global boom in public funding for biomedical research, giving the NIH more money than any president asked for over many decades. Now, it might be the US Congress that lets the boom subside. If that happens, thousands of young researchers who have committed their lives and careers to the field could be left in the lurch.

''We've got this system that's pump-primed all these young people, and now there's nowhere for them to go,'' says Crabb at the AAMRI. For some, attention is turning to what they should be told to do instead. ''Only one in ten postdocs is going to become a principal investigator,'' says Downs. ''This hasn't been conveyed to them powerfully enough.''

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