embryonic stem-cell research. "The polls and surveys show the American public is morally behind there being some limited form of embryonic stem-cell research funded by federal money. They don't favour cloning. There is not a huge amount of support for creating embryos from scratch for research. But there seems to be pretty wide support among the general public for the kind of embryonic stem-cell research that the NIH is currently funding."

In the end, however, the debate about public funding for stem-cell research is only part of the picture, given the role of private business and states. Glenn McGee, a professor at the Center for Practical Bioethics in Kansas City, MO, USA, and editor of the *American Journal of Bioethics*, commented

that perhaps too much emphasis is being put on federal funding. He said that funding from states such as California and from industry—which are not restricted—has become a more important force than NIH funding. "We're a little bit delusional if we think that this is a moment where the country is making a big decision about what's going to happen with stem cells," he said. "I think that ship has sailed."

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Facing the credit crunch

Politics sends mixed messages for science in the wake of the global financial crisis

Philip Hunter

The overall state of biomedical research in the wake of the global financial crisis remains unclear amid growing concern that competition for science funding is compromising the pursuit of research. Such concerns pre-date the credit crunch, but there is a feeling that an increasing amount of time and energy is being wasted in the ongoing scramble for grants, in the face of mounting pressure from funding agencies demanding value for money. Another problem is balancing funding between different fields; while the biomedical sciences have generally fared well, they are increasingly dependent on basic research in physics and chemistry that are in greater jeopardy. This has led to calls for rebalancing funding, in order to ensure the long-term viability of all fields in an increasingly multidisciplinary and collaborative research world.

For countries that are cutting funding—such as Spain, Italy and the UK—the immediate priority is to preserve the fundamental research base and avoid a significant drain of expertise, either to rival countries or away from science altogether. This has highlighted the plight

of postdoctoral researchers who have traditionally been the first to suffer from funding cuts, partly because they have little immediate impact on a country's scientific competitiveness. Postdocs have been the first to go whenever budgets have been cut, according to Richard Frankel, a physicist at California Polytechnic State University in Saint Luis Obispo, who investigates magnetotaxis in bacteria. "In the short term there will be little effect but the long-term effects can be devastating," he said.

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According to Peter Stadler, head of a bioinformatics group at the University of Leipzig in Germany, such cuts tend to cause the long-term erosion of a country's science skills base. "Short-term cuts in science funding translate totally into a brain drain, since they predominantly affect young researchers

who are paid from the soft money that is drying up first," said Stadler. "They either leave science, an irreversible step, or move abroad but do not come back later, because the medium-term effect of cuts is a reduction in career opportunities and fiercer competition giving those already in the system a big advantage."

Even when young researchers are not directly affected, the prevailing culture of short-term funding—which requires ongoing grant applications—can be disruptive, according to Xavier Salvatella, principal investigator in the Laboratory of Molecular Biophysics at the Institute for Research in Biomedicine in Barcelona, Spain. "I do not think the situation is dramatic but too much time is indeed spent writing proposals," he commented. "Because success rates are decreasing, the time devoted to raise funds to run the lab necessarily needs to increase."

At the University of Adelaide in Australia, Andrew Somogyi, professor of pharmacology, thinks that the situation is serious: "[M]y postdocs would spend about half their time applying for grants." Somogyi pointed out that the success rate has been declining in Australia, as it has in some other countries. "For ARC [Australian Research Council] the success rate is now close to 20%, which means many excellent projects don't get funding because the assessment is now so fine cut," he said.

Similar developments have taken place in the USA at both the National Institutes of Health (NIH)—which provides US\$16 billion funding per year and the American Cancer Society (ACS), the country's largest private non-profit funder of cancer research, with a much smaller pot of US\$120 million per year. The NIH funded 21% of research proposals submitted to it in 2009, compared with 32% a decade earlier, while the ACS approves only 15% of grant applications, down several percentage points over the past few years.

While the NIH is prevented by federal law from allowing observers in to its grant review meetings, the ACS did allow a reporter from *Nature* to attend one of its sessions on the condition that the names of referees and the applications themselves were not revealed (Powell, 2010). The general finding was that while the review process works well when around 30% of proposals are successful, it tends to break down as the success rate drops, as more arbitrary decisions are made and the risk of strong

pitches being rejected increases. This can also discourage the best people from being reviewers because the process becomes more tiring and time-consuming.

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In some countries, funding shortfalls are also leading to the loss of permanent jobs, for example in the UK where finance minister George Osborne announced on October 20 that the science budget would be frozen at £4.6 billion, rather than cut as had been expected. Even so, combined with the cut in funding for universities that was announced on the same day, this raises the prospect of reductions in academic staff numbers, which could affect research projects. This follows several years of increasing funding for UK science. Such uncertainty is damaging, according to Cornelius Gross, deputy head of the mouse biology unit, European Molecular Biology Laboratory in Monterotondo, Italy. "Large fluctuations in funding have been shown to cause damage beyond their direct magnitude as can be seen in the US where the Clinton boom was inevitably followed by a slowdown that led to rapid and extreme tightening of budgets," he said.

Some countries are aware of these dangers and have acted to protect budgets and, in some cases, even increase spending. A report by the OECD argued that countries and companies that boosted research and development spending during the 'creative destruction' of an economic downturn tended to gain ground on their competitors and emerge from the crisis in a relatively stronger position (OECD, 2009). This was part of the rationale of the US stimulus package, which was intended to provide an immediate lift to the economy and has been followed by a slight increase in funding. The NIH's budget is set to increase by \$1 billion, or 3% from 2010 to 2011, reaching just over \$32 billion. This looks like a real-term increase, since inflation in the USA is now between 1 and 2%. However, there are fears that budgets will soon be cut; even now the small increase at the Federal level is being offset by cuts in state support, according to Mike Seibert, research fellow at the US Department of Energy's National Renewable

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Energy Laboratory. "The stimulus funds are disappearing in the US, and the overall budget for science may be facing a correction at the national level as economic, budget, and national debt issues are addressed," he said. "The states in most cases are suffering their own budget crises and will be cutting back on anything that is not nailed down."

In Germany, the overall funding situation is also confused by a split between the Federal and 16 state governments,

each of which has its own budget for science. In contrast to many other countries though, both federal and state governments have responded boldly to the credit crisis by increasing the total budget for the DFG (Deutsche Forschungsgemeinschaft)—Germany's largest research funding agency—to €2.3 billion in 2011. Moreover, total funding for research and education from the BMBF (Federal Ministry for Education and Research) is expected to increase by another 7% from €10.9 billion in 2010 to €11.64 billion, although the overall federal budget is set to shrink by 3.8% under Germany's austerity measures (Anon, 2010). There have also been increases in funding from non-government sources, such as the Fraunhofer Society, Europe's largest application-oriented research organization, which has an annual budget of €1.6 billion.

The German line has been strongly applauded by the European Union, which since 2007 has channelled its funding for cutting-edge research through the European Research Council (ERC). The ERC's current budget of €7.5 billion, which runs until 2013, was set in 2007 and negotiations for the next period have not yet begun, but the ERC's executive agency director Jack Metthey has indicated that it will be increased: "The Commission will firmly sustain in the negotiations the view that research and innovation, central to the Europe 2020 Strategy agreed by the Member States, should be a top budgetary priority." Metthey also implied that governments cutting funding, as the UK had been planning to do, were making a false economy that would gain only in the short term. "Situations vary at the national level but the European Commission believes that governments should maintain and even increase research and innovation investments during difficult times, because these are pro-growth, anti-crisis investments," he said.

Many other countries have to cope with flat or declining science budgets; some are therefore exploring ways in which to do more with less. In Japan, for instance, money has been concentrated on larger projects and fewer scientists, with the effect of intensifying the grant application process. Since 2002, the total Japanese government budget for science and technology has remained flat at around ¥3,500 billion—or €27 billion at current exchange rates—with a 1% annual decline in university support but increased funding for projects considered to be of high value to the economy. This culminated in March 2010 with the launch of the ¥100 billion (€880 million) programme for World Leading Innovative Research and Development on Science and Technology.

But such attempts to make funding more competitive or focus it on specific areas could have unintended side effects on innovation and risk taking. One side effect can be favouring scientists who may be less creative but good at attracting grants, according to Roger Butlin, evolutionary biologist at the University of Sheffield in the UK. "Some

productive staff are being targeted because they do not bring in grants, so money is taking precedence over output," said Butlin. "This is very dangerous if it results in loss of good theoreticians or data specialists, especially as the latter will be a critical group in the coming years."

"Scientists are usually very energetic when they can pursue their own ideas and less so when the research target is too narrowly prescribed"

There have been attempts to provide funding for young scientists based entirely on merit, such as the ERC 'Starting Grant' for top young researchers, whose budget was increased by 25% to €661 million for 2011. Although they are welcome, such schemes could also backfire unless they are supported by measures to continue supporting the scientists after these early career grants expire, according to Gross. "There are moves to introduce significant funding for young investigators to encourage independence, so called anti-brain-drain grants," he said. "These are dangerous if provided without later independent positions for these people and a national merit-based funding agency to support their future work."

Such schemes might work better if they are incorporated into longer-term funding programmes that provide some security as well as freedom to expand a project and explore promising side avenues. Butlin cited the Canadian 'Discovery Grant' scheme as an example worth adopting elsewhere; it supports ongoing programmes with long-term goals, giving researchers freedom to pursue new lines of investigation, provided that they fit within the overall objective of the project.

To some extent the system of 'open calls'—supported by some European funding agencies—has the same objective, although it might not provide long-term funding. The idea is to allow scientists to manoeuvre within a broad objective, rather than confining them to specific lines of research or 'thematic calls', which

tend to be highly focused. "The majority of funding should be distributed through open calls, rather than thematic calls," said Thomas Höfer from the Modeling Research Group at the German Cancer Research Center & BioQuant Center in Heidelberg. "Scientists are usually very energetic when they can pursue their own ideas and less so when the research target is too narrowly prescribed. In my experience as a reviewer at both the national and EU level, open calls are also better at funding high-quality research whereas too narrow thematic calls often result in less coherent proposals."

"Cutting science, and education, is the national equivalent of a farmer eating his 'seed corn', and will lead to developing nation status within a generation"

Common threads seems to be emerging from the different themes and opinions about funding: budgets should be consistent over time and spread fairly among all disciplines, rather than focused on targeted objectives. They should also be spread across the working lifetime of a scientist rather than being shot in a scatter-gun approach at young researchers. Finally, policies should put a greater emphasis on long-term support for the best scientists and projects, chosen for their merit. Above all, funding policy should reflect the fundamental importance of science to economies, as Seibert concluded: "Cutting science, and education, is the national equivalent of a farmer eating his 'seed corn', and will lead to developing nation status within a generation."

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