



2021-22 Pre-Budget Submission

The Australian Academy of Science (the Academy) welcomes the opportunity to make recommendations for consideration in the Commonwealth Government budget for 2021-22.

The previous 18 months have presented extraordinary and devastating challenges to Australia, from bushfires to the COVID-19 pandemic. As the country looks to the year ahead, two things are certain: that science is at the heart of every viable path forward, and that these devastating events that have previously been described as 'once-in-a-century', will become more frequent and more severe.

Science and technology continue to offer the only exit strategy from the pandemic for Australia and the world. Our nation has been well served by policymakers being able to access the scientific evidence base. The Academy asserts that mechanisms that brought science to the heart of government are gains that should not be lost during our recovery.

Science and technology offers the only exit strategy from COVID-19 – for Australia and the world.

Our critical national science capabilities must not be permanent casualties of the global crisis. Only by drawing on science can we prepare for future national emergencies and generate the knowledge that will propel Australia for years to come. Without these capabilities, Australian Government priorities such as the Technology Investment Roadmap will not be implemented, and the ambition of the Modern Manufacturing Strategy not achieved.

Modern science is inherently an international activity, and science has a vital role in diplomacy in our region and worldwide. International collaboration benefits Australian scientists by giving them access to infrastructure and data to accelerate and amplify their discoveries. It also benefits Australia by offering opportunities to create strategic international partnerships and boost capacity in our region.

Our key recommendations to the Australian Government for the 2021-22 budget are as follows:

- Maintain sovereign capabilities in research and development by establishing a research translation fund to support research not covered by the Medical Research Future Fund (MRFF). We suggest that a comprehensive review of Australia's research system is required, and continued support for the research workforce.
- Conduct a 12-month review of higher education funding rates for university teaching of Science, Technology, Engineering and Mathematics (STEM) subjects.
- Continue to provide the evidence base to the Australian government through the Rapid Research Information Forum (RRIF) and investment in its operations and the learned Academies' policy capability.
- Commence a roadmap for developing additional vaccine manufacturing capability within the next twelve months.
- Work with Taxonomy Australia to scope a mission to discover all species within a generation, commencing with a full cost-benefit exercise.

Science as a sovereign capability

Our sovereign scientific capabilities, and the extraordinary mobilisation of science and research to address this global crisis, has helped ensure that Australia has to date escaped the worst impact of COVID-19.

The year 2020 demonstrated that the research sector could provide government rapid and robust responses to policy imperatives. The sector's capacity is no accident. Instead, it results from decades of investment in education, research (especially fundamental and discovery research), research careers, research infrastructure, and scientific agencies. This capacity has been demonstrated by the rapid, and unprecedented, development of a vaccine within twelve months of the publication of the genomic sequence by Australian scientist Professor Eddie Holmes FAA and Chinese scientist Yong-Zhen Zhang.¹

However, defects in Australia's unsustainable approach to funding and organising research and development have been exposed. Despite the Australian Government's additional investments in the 2020-21 budget, the ongoing negative impact on the scientific enterprise of the pandemic will become more apparent during 2021.

Australia's investment in research and development as a proportion of GDP was already falling before the pandemic. Business R&D, already lower than any year since 2003, is widely expected to fall further.² Australian universities' exposure and dependence on international education to fund Australian research is an urgent risk that will require further policy reform to be addressed.

The Academy has long sought an uplift in our national scientific ambition, including an increase in our national R&D effort to 3 per cent of GDP. This ambition requires broad agreement on how to focus any additional funding for science and research on societal challenges, particularly uniquely Australian challenges, such as the health of crucial economic and environmental assets like the Murray Darling Basin and the Great Barrier Reef.

Addressing these challenges requires broad reform to instruments like our R&D tax incentives and the pursuit of a productivity-enhancing Australian open science strategy.

Central to this is an appreciation that we cannot expect other nations to invest in strategic research impacting uniquely Australian issues. There are certain fields of knowledge and expertise where a sovereign science capability is of strategic national importance.

Recommendation

Given the complex nature of research funding and the myriad of stakeholders involved, it is recommended that a comprehensive review of the Australian system of research funding be undertaken to determine the most sustainable and effective way to support the research and development our nation so heavily relies on.

OECD calls for global action to safeguard science systems

On January 12, the OECD released the Science, Innovation and Technology Outlook 2021.² The Outlook focuses on the COVID-19 pandemic, illustrating the extraordinary mobilisation of public and private science. The report has made six broad policy recommendations:

1. Policy needs to be able to guide innovation efforts to where they are most needed.
2. The multifaceted nature of addressing complex problems like COVID-19 and climate change underscores the need for transdisciplinary research to which current science system norms and institutions are ill-adapted. Disciplinary and hierarchical structures need to be adjusted to promote transdisciplinary research that engages different disciplines and sectors to address complex challenges.
3. Governments should link support for emerging technologies, such as engineering, biology and robotics, to broader missions like health resilience that encapsulate responsible innovation principles.
4. Reform PhD and post-doctoral training to support a diversity of career paths are essential for improving societies' ability to react to crises and deal with future challenges like climate change that require science-based responses.
5. Global challenges require global solutions that draw on greater international scientific co-operation.
6. Governments need to renew their policy frameworks and capabilities to fulfil a more ambitious science policy agenda. Governments should also continue to invest in evidence about their science support policies.

Ensuring the Future Research Workforce

A generation of researchers is being lost. The full impacts of damage to the science and research workforce from the pandemic may not be completely apparent until our next national emergency. A diminished research capability will mean we are less prepared and able to respond and adapt to future emergencies. As Australia recovers from the pandemic's wide-ranging impacts, the science and research system that has served the nation well must be placed on a more sustainable, and secure basis.

The next generation of science relies on a very precarious system, mainly temporary work structures in universities leaving early and mid-career researchers' positions unstable and vulnerable and disproportionately impacting women. While not a uniquely Australian problem, the research workforce's level of casualisation is well above comparable OECD nations.²

There is a range of options that can be considered, such as covering the gap in the pipeline through offering more Discovery Early Career Researcher Awards, or Future Fellowships;

continuing and funding a greater diversity of schemes for industry and academia collaboration; and a program to transition EMCRs who have lost positions during the pandemic into roles that will allow their STEM skills to be of use.

Recommendation

The research workforce be supported through targeted schemes to transition to areas of national need, or into industry, where appropriate. This could include providing emergency one off funding to the research councils (ARC and NHMRC) to provide targeted support to early and mid-career researchers.

Science for Australians

Australia's response to the pandemic has been successful, including the ability to integrate the latest evidence into policy deliberations. The experience of utilising rapid science and research advice to inform public policy should be carried forward into new challenges such as the decarbonisation and digitalisation of our economy and society.

In 2018 an OECD report called upon governments to develop national mechanisms to provide scientific advice in crises.³ It also called for the fostering of domestic capability in science policy and advice. Indeed, the routine provision of scientific evidence from independent, authoritative, and trusted sources to inform policymaking has been mostly absent in Australia. There are few permanent and structural mechanisms for the provision of independent scientific advice to government.

The Rapid Research and Information Forum's (RRIF), chaired by the Chief Scientist, fills this gap. RRIF provides relevant, timely and accessible evidence informing policy to a non-specialist audience. Significantly, the reports are based on the nation's leading researchers' knowledge of the balance of the evidence, are multidisciplinary, and are not the views of one expert, opinion, or cherry-picked data.

RRIF can benefit the Australian Government beyond the pandemic by providing evidence-based answers to questions to inform a range of policy challenges, from adaption to global warming, the challenge of a circular economy, and building sovereign capability in manufacturing. There are few if any policy areas that do not have an underlying evidence base.

Recommendation

The Academy calls for the RRIF to be continued by investing in its operations and the learned Academies' policy capability in order to provide to the Australian Government the evidence base to inform public policy.

Expanding our sovereign capability to manufacture vaccines

The Australian Academy of Science believes that despite our one-hundred-year-old investment in CSL, there are gaps in our ability to produce vaccines onshore. Without the ability to produce vaccines onshore, Australia and the region remain vulnerable to supply shocks and outbreaks of “vaccine nationalism”.

Investing in nucleic acid-based technology platforms offers a way to mitigate this risk. These platforms can, within weeks of identifying an emerging strain of a virus with antibody-evading

mutations whether it is COVID-19 or future as yet unknown virus or biosecurity risks, modify and manufacture vaccine formulation to incorporate these mutations. One manifestation of this technology is RNA manufacturing where Australia is dependent on Europe and North America for supply,

Currently, Australia cannot mass produce the nucleic acid-based technology part of the vaccine, but can produce adjuvants and complete the formulation, fill and finish capability. The capacity to manufacture entire recombinant protein-based vaccines exists locally. The issue with this is that there is a long lag time between determining likely mutations and producing a new vaccine for the mutant virus strains (e.g. the flu vaccine).

Nucleic acid technology shows enough promise to commit to developing a large-scale production capability, Australia needs a strategy for developing additional manufacturing platforms for the years ahead.

Recommendation

The Academy calls upon the Australian Government to develop additional onshore vaccine nucleic acid manufacturing capability.

University STEM education and research

Australia should strive to produce science, technology, engineering, and mathematics (STEM) graduates who are ready to fill jobs and understand how to create jobs. Ensuring that the next generation of Australian researchers is adequately trained, with expertise crucial to our national interest, and that we have access to the infrastructure needed to conduct research will safeguard Australia's economic future.

The passage and implementation of the Australian government's Job-Ready package are intended to incentivise STEM study. The Academy is aware of announced job cuts and course changes across several universities, both of which are impacting the staffing levels in STEM areas – particularly mathematics, physics, and chemistry – and reduces opportunities for Australians to study and research in science. While it is unclear whether these restructures are a response to legislated changes in cluster funding rates and student contribution levels, or reflect the pandemic's ongoing impact on universities, such developments are of concern.

Recommendation

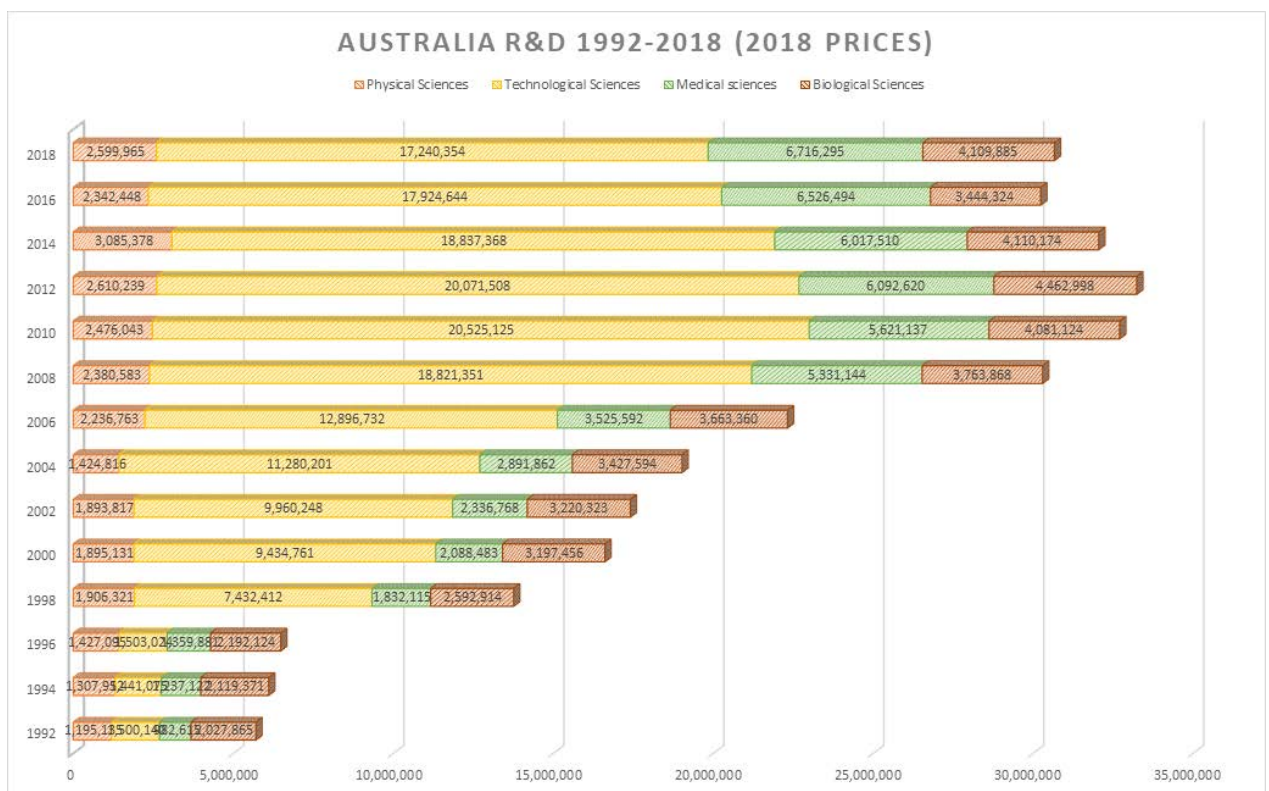
The Academy calls upon the Australian Government to monitor real-world impacts on the study and research of STEM, and be prepared to review funding clusters 12 months after implementing the Job-ready graduate program.

Fundamental science foundation of translation pipeline

Fundamental research (understood as basic research defined by the Australian Bureau of Statistics) has received a declining share of university and government support for decades. In 1998, 58 per cent of university resources devoted to research and development were spent on basic research. By 2018 this allocation had fallen to 41 per cent.⁴ The pandemic's impact on research in Australian universities may see a further decline in the proportion of resources for fundamental research in the coming years.

The Commonwealth is responsible for much of the funding of fundamental research in the Australian innovation system. Given this, policy should have a greater appreciation of the need for such research to feed the innovation value chain that ultimately leads to adopting new technologies.

The primary purpose of fundamental research is to generate new knowledge and better understand nature and its laws. In this way, it generates ‘scientific capital’, or a repository from which applications can be drawn. The National Science Foundation has stated, “a nation which depends upon others for its new basic scientific knowledge will be slow in its industrial progress and weak in its competitive position in world trade, regardless of its mechanical skill.”⁵ Such investments in Australian fundamental science, from mathematics to materials science and beyond, will build our nations scientific capital and enable industries of the future.



Stagnant real investment in physical sciences concerns the Academy for several reasons:

- Eleven per cent of Australian economic activity relies directly on advanced physical and mathematical sciences.
- The time between discovery and economic application can be twenty or more years.
- Discoveries in the physical sciences can have several critical applications central to economic and social wellbeing. Such as the importance of chemistry to modern manufacturing, or physics to our ambitions to develop an Australian space industry, or mathematics to the functioning of a modern data and banking system.

Australia has been able to position itself as a leading biomedical nation. Such a position is no accident but has come from decades of patient investment. The establishment of the Medical

Research Future Fund has positioned this sector for further growth. Now is the time to make similar patient investments in physical sciences.

Recommendation

The Academy calls upon the Australian Government to establish a research translation fund to support university and science agency research not eligible for the MRFF. Such a fund should operate according to accepted modes of governance: highest possible transparency, peer review, clear priorities, and managed by the Australian Research Council.

Taxonomy – An exercise in quantifying our natural/environmental capital

Biologically, Australia is one of the richest and most diverse nations on Earth.

Australia's biodiversity is an invaluable resource, opportunity and responsibility for the present and future generations. It underpins economic growth in existing, new and emerging industries including in medicine, health and agriculture. It supports and sustains our environment and our society. It gives character and meaning to our landscapes and helps make Australia globally unique and remarkable.

And yet, our biodiversity is only partially known and documented. It is estimated that less than one-third of the more than 700,000 species of plants, animals, fungi and other organisms that occur in Australia have been discovered and documented after more than three centuries of Western scientific endeavour. 70% of all our species remain undiscovered and unnamed and are practically invisible. This represents an enormous hidden asset for Australia's future.

Our poor knowledge of Australian species is a serious risk. We face the multiple challenges of species extinction, global environmental change, bushfires, pests and diseases, pollution and other threats to our environment, agriculture and economy.

Australia's taxonomists—the scientists who discover, name, document and classify species—are planning an ambitious mission: to discover and document all remaining Australian species within a generation, and to vastly expand and improve our knowledge and understanding of all Australian species of plants, animals, fungi and other organisms.

Taxonomists build the 'map' that others, in government, industry and the community, use to understand our biodiversity. At present, 70% of the 'map' of Australia's biodiversity is blank.

Using new and emerging technologies, this mission is possible. By harnessing the scientific expertise of this generation and the next, it can be achieved. If achieved, it will add to Australia's prosperity. A recent cost-benefit scoping exercise by Deloitte Access Economics has estimated that a mission to discover and document all remaining Australian species within a generation will provide returns of at least \$4–\$35 for every dollar invested.

That is, the benefits of documenting our hidden biodiversity—for conservation, development, biosecurity and industry—will outweigh the investment many times over.

Australia's biodiversity is a global responsibility and one of our most important national assets. A mission to discover and adequately document Australia's biodiversity and its species will enable us to make full use of, and take full responsibility for, our uniquely rich

biodiversity, and will place us at the forefront of global efforts to protect, manage and benefit from the world's environment and its species.

Recommendation

The Academy calls for the Australian Government to work with Taxonomy Australia to scope a mission to discover all species within a generation, commencing with a full cost-benefit exercise.

Science driving regional diplomacy

The practise of science is an international endeavour. Science has time and time again proven itself to be an effective and powerful soft power asset playing an essential role in building strategic partnerships between countries. The exchange of scientific ideas, methods, infrastructure and outcomes allows researchers to amplify their efforts. In particular, as demonstrated by the COVID-19 pandemic, the free exchange of research data is critical for research to progress rapidly, effectively and efficiently.

Opportunities for Australia to take leadership in science in the Asia-Pacific region should be considered for investment. For example, Australia may wish to produce a bid to host the International Science Council's Regional Office for the Asia Pacific. If Australia were to host the regional office, it would effectively put the country at the centre of setting science priorities for the region and strengthening international partnerships.

The Academy also supports calls for investment in developing research capability, and professional development, for indigenous knowledge practitioners, including scientists.

References

1. Novel 2019 coronavirus genome - SARS-CoV-2 coronavirus . *Virological* <https://virological.org/t/novel-2019-coronavirus-genome/319> (2020).
2. Organisation for Economic Co-operation and Development. *OECD Science, Technology and Innovation Outlook 2020*. (OECD, 2021). doi:10.1787/75f79015-en.
3. Organisation for Economic Co-operation and Development. *Scientific Advice During Crises*. *Scientific Advice During Crises* (OECD, 2018). doi:10.1787/9789264304413-en.
4. Australian Bureau of Statistics. Research and Experimental Development, Higher Education Organisations, Australia. <https://www.abs.gov.au/statistics/industry/technology-and-innovation/research-and-experimental-development-higher-education-organisations-australia/latest-release> (2018).
5. Bush, V. Science, the Endless Frontier: A Report to the President on a Program for Postwar Scientific Research. <https://www.nsf.gov/od/lpa/nsf50/vbush1945.htm>.