Australian Academy of Science

SUBMISSION TO THE

SENATE ECONOMICS REFERENCES COMMITTEE INQUIRY INTO AUSTRALIA'S INNOVATION SYSTEM

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AUSTRALIAN ACADEMY OF SCIENCE SUBMISSION TO THE SENATE ECONOMICS REFERENCES COMMITTEE INQUIRY INTO AUSTRALIA'S INNOVATION SYSTEM

KEY POINTS FROM THE ACADEMY'S SUBMISSION

1. **Australia must invest in education and skills to have a comparative advantage if it is to attract investment in innovation to secure high-skill, high-wage jobs and industries.**
2. **The leadership shown in developing a long-term vision for medical research needs to be extended to other areas of the science, research and innovation system.**
3. **Cultural change within the research and innovation system, along with access to financial support, including venture capital, is needed if Australia is to make the most of its investment in research by translating it into social and economic benefits.**
4. **A positive business environment where policies are in place to encourage investment in innovation is needed to ensure the benefits of Australian research are realised in Australia, rather than commercialised overseas.**
5. **The proposed deregulation of undergraduate student contributions and the introduction of postgraduate tuition fees have the potential to discourage students from studying science, which might lead to a future skills shortage.**
6. **A long-term financial commitment to building and operating national research infrastructure is needed if Australia is to get the most from its past substantial investments, and if it is to undertake world leading science and research.**
7. **Whilst not a replacement for public investment in research, Australia needs to grow the role of philanthropy for research.**
8. **Australia needs a coherent research workforce strategy that is forward looking and ensures that we have both the research capacity and mix of skills in our research workforce to meet national requirements in the future. We need to map out what is the right amount and balance of awards and fellowships at different career stages.**
9. **Investing in international science collaboration must be seen as an essential and necessary component of our existing science investment.**

RESPONSE TO THE INQUIRY'S TERMS OF REFERENCE

(A) THE NEED TO ATTRACT NEW INVESTMENT IN INNOVATION TO SECURE HIGH SKILL, HIGH WAGE JOBS AND INDUSTRIES IN AUSTRALIA, AS WELL AS THE ROLE OF PUBLIC POLICY IN NURTURING A CULTURE OF INNOVATION AND A HEALTHY INNOVATION ECOSYSTEM

The issue to consider is not whether investment in innovation is worthwhile or needed, but why would those seeking to make such an investment choose Australia? Australia cannot compete with most nations in terms of labour cost, and without sustained investment and focus it risks losing its comparative skills advantage.

Australia's economy is in a period of transition. The traditional manufacturing sector has lost 87,000 jobs over the last five years, and is projected to lose a further 40,000 jobs over the next five years (Department of Employment 2014). Mining has been a source of prosperity in Australia in recent years, but expert forecasts predict there will be a net loss of 12,000 in mining jobs over the next five years (Department of Employment 2014). The continuing decline in employment in agriculture, forestry and fishing is also set to continue over

the next five years, with a further net 2,800 jobs predicted to be lost. Since these Department of Employment (2014) forecasts were made, the remaining automotive manufacturers have announced their intention to cease manufacturing operations in Australia. The Productivity Commission has documented claims that the automotive manufacturing sector indirectly employs up to 200,000 people, and directly employs 45,000 people (Productivity Commission 2014). The reasons behind this transitioning economy in Australia are multiple. They include the rise in the dollar over a comparatively short period of time, relatively slow productivity growth, lower consumer confidence, increased costs of raising capital for Australian businesses, and the rise of low-cost manufacturing centres in Asia and elsewhere (Prime Minister's Manufacturing Taskforce 2012).

The globalised nature of the Australian economy means that such a transition will continue unabated. To some extent, Australia has managed to weather this transition by moving towards a knowledge economy. Over the last five years, 107,500 new professional, scientific and technology jobs and 97,000 new jobs in higher education have been created (Department of Employment 2014). More new jobs have been created over the last five years in these 'knowledge economy' professions than in mining, accommodation and food, or in construction. In recent years, new job creation has, to a large extent, depended on us exploiting our relatively high level of skills. This has been made possible because in decades past we have made investments in education and skills over previous decades.

We cannot assume that Australia is able to automatically grow its knowledge economy. Other developed economies have responded to this challenge by increasing their investment in science, research and education. We are entering a new era of competition to develop and attract high-skill industries and jobs. The results of investment by our international peers, and Australia's faltering efforts are starting to show. In 2000, Australian teenagers outperformed all other OECD nations in science with the exception of Japan and Korea. By 2012 Shanghai, Hong Kong, Singapore, Finland, Estonia and Korea had all caught up with Australia (Thomson, De Bortoli & Buckley 2013). Nations that have outcompeted us in many of the traditional areas of the economy, such as manufacturing, are now positioning themselves to compete with Australia for high-skill, high-wage jobs. As the level of international investment continues, the level of competition will only increase.

(B) THE AUSTRALIAN GOVERNMENT'S APPROACH TO INNOVATION, ESPECIALLY WITH RESPECT TO THE FUNDING OF EDUCATION AND RESEARCH, THE ALLOCATION OF INVESTMENT IN INDUSTRIES, AND THE MAINTENANCE OF CAPABILITIES ACROSS THE ECONOMY

The absence of any coherent approach to science, research and innovation, and continued cuts under the previous and present government, will reduce sector capability. The leadership shown in developing a long-term vision for medical research needs to be extended to other areas of the science, research and innovation system.

Funding for science, research and innovation suffered in the final years of the previous government, falling by $141 million in 2012–13, and then by an estimated $329 million as a result of the previous government's final budget for 2013–14 (Department of Industry 2013). The present government has not reversed the cuts, but in its first budget, made a series of further deep cuts to key science agencies and innovation funding programs. Programs that were designed to improve on Australia's relatively low levels of innovation such as the Innovation Investment Fund, Commercialisation Australia, and Enterprise Solutions have been discontinued, and replaced with less ambitious and greatly scaled back programs. The amount of support available through the R&D tax incentive for businesses to engage in research and development has been reduced. In addition, there will no new Cooperative Research Centres funded in 2014 and the future of the scheme is under review.

The current government must articulate its vision and policies for investment in science and innovation as drivers of economic growth and the development of new industries.

(C) THE IMPORTANCE OF TRANSLATING RESEARCH OUTPUT INTO SOCIAL AND ECONOMIC BENEFITS FOR AUSTRALIANS, AND MECHANISMS BY WHICH IT CAN BE PROMOTED

Attempts to increase the amount of research translated into social and economic benefits will require cultural change within the Australian research system. For this to happen, government and researcher organisations need to recognise and encourage researchers to engage in research translation. In addition, policies are required that will create an environment in which financial support, including venture capital, is available to help commercialise the results of research in Australia.

Research translation can be regarded as the translation of research findings into practice, policy or further research (Hiscock, Goldfield & Davies 2011), and this includes the commercialisation of research findings.

Translating research outputs into social and economic benefits for Australians should be seen as an area requiring priority policy actions. Research translation can deliver real social and economic benefits that lead to improved social, economic, health and environmental outcomes. Delivering tangible benefits justifies the initial investment in research to the community, particularly in fiscally challenging environments, and helps to promote ongoing investment in research.

Whilst, by most measures, we have a high quality research system producing world-class research in many fields (for example see Office of the Chief Scientist 2012; Australian Research Council 2012), the same cannot be said about our innovation system. We are less successful at making our outstanding scientific breakthroughs into tangible products or applying them to existing processes to deliver economic and social benefits. The difficulties relating to undertaking research translation, and particularly the commercialisation of our research, should be areas which the government and the sector address as a priority. The Academy sees two policy areas that should be a priority: (i) cultural and organisational barriers within the research system; and (ii) the difficulties of commercialising the result of research in Australia.

There are systemic cultural and organisational barriers within the research system that prevent research translation being undertaken on the scale that is needed to deliver benefits to Australia. Researchers in universities are rewarded (in terms of their career and research profile) for undertaking research activities. Career progression is based largely upon peer-reviewed publication history, and past success at obtaining competitive research council grants. Academia is a highly competitive arena, and spending any amount of time away from concentrating on these activities can disrupt career progression. Researchers are rarely rewarded and supported to pursue research translation activities and industry collaboration. Instead, the present system encourages researchers to complete a research project, and then move onto the next piece of research rather than stop and think about how that research might be used to change current practices or policy, or how it could be developed into a commercial product. For example, in terms of medical sciences, the Chief Scientist has noted that it takes a minimum of 6.3 years for evidence to reach reviews, papers and textbooks, and that it then takes an additional 9.3 years to implement evidence from those reviews, papers and textbooks (Office of the Chief Scientist 2012a). A similar situation exists in other disciplines. Aside from goodwill, there are very few incentives and a number of career disincentives in the research system for researchers to work with clinicians, entrepreneurs, practitioners and policy makers to reduce this lag time.

Our current system for supporting research generally takes research to the point of demonstrating a concept in the lab, but unfortunately not much further. This 'valley of death' between research and a solid pathway to commercialisation has been identified as the major barrier to innovation and to research commercialisation (see for example, Department of Innovation, Industry, Science and Research 2009; Office of the Chief Scientist 2012a; 2013). Whilst this problem is not unique to Australia (for example see House of Commons 2011), it is particularly acute here. The critical importance of commercialising research can be seen in recent success stories which are delivering benefits to Australia, for example high profile products such as Biota's flu treatment (Relenza), CSL's anti-cancer vaccine (Gardasil), CSIRO's polymer bank notes and wireless technology,

and the Cochlear bionic ear. The benefits to Australia are considerable; however, given the quality of Australian science, there should be far more examples of such success, and there are too many roadblocks and disincentives that hinder the pathway for translating research into a useful product or process.

Commercialisation barriers exist, in part, because of a lack of venture capital opportunities, low levels of business R&D, and an absence of very large global technology businesses. Australian scientists and innovators are too often forced to take their work overseas where access to capital and market conditions is much more favourable. The result is that the research translation benefits that come from commercialising and innovating occurs overseas, and the economic benefits are mostly delivered overseas, costing Australia jobs, wealth, and the opportunity to build new industries (Department of Innovation, Industry, Science and Research 2009).

(D) THE RELATIONSHIP BETWEEN ADVANCED MANUFACTURING AND A DYNAMIC INNOVATION CULTURE

Australia needs to develop a positive business environment in which investment in innovation is encouraged, particularly through the R&D tax incentive, support for basic, applied and translational research, and ensuring Australia has the skills necessary to succeed. Where necessary, public investment to overcome market failures will be needed to ensure that innovation can take place in Australia rather than allowing the benefits of Australian research to be commercialised overseas.

Innovation is crucial to developing advanced manufacturing industries, and the Academy's comments in response to the inquiry's terms of reference (C) covering the importance of innovation and translating research into outputs are relevant to developing advanced manufacturing.

The US President's Council of Advisors on Science and Technology (2011) described advanced manufacturing as 'a family of activities that (a) depend on the use and coordination of information, automation, computation, software, sensing, and networking, and/or (b) make use of cutting edge materials and emerging capabilities enabled by the physical and biological sciences, for example nanotechnology, chemistry and biology. It involves both new ways to manufacture existing products, and the manufacture of new products emerging from new advanced technologies'. The Academy agrees with the Council's broad recommendation that policy actions be taken in three important areas: (i) enabling innovation; (ii) securing the talent pipeline; and (iii) improving the business pipeline.

It should not be assumed that the loss of manufacturing jobs in Australia has been (and will continue to be) restricted to low-wage jobs in low-tech industries, and it must be assumed that low-wage nations will increasingly compete with Australia for investment in advanced manufacturing. As outlined in the Academy's response to term of reference (a), Australia cannot compete with many nations in terms of labour costs, and must ensure that its other areas of competitive advantage are in place. We must have a highly skilled workforce, and developing a favourable environment in which to investment in innovation.

(E) CURRENT POLICIES, FUNDING AND PROCEDURES OF AUSTRALIA'S PUBLICLY-FUNDED RESEARCH AGENCIES, UNIVERSITIES, AND OTHER ACTORS IN THE INNOVATION SYSTEM

The major policy initiatives of the current government affecting Australia's publicly-funded research agencies, universities and other actors in the innovation system have primarily focused around three areas:

- **(i) the scaling back the innovation system by reducing public investment in science, research and innovation**
- **(ii) the intention to develop a Medical Research Future Fund to deliver additional investment medical research at some point in the future**
- **(iii) the proposed deregulation of undergraduate student contributions, and the introduction of tuition fees for postgraduate students.**

There are very few details about the proposed Medical Research Future Fund beyond what is stated in the Budget papers, that is that the net earnings from '…the Fund will serve as a permanent revenue stream, primarily to the National Health and Medical Research Council (NHMRC)' (Commonwealth of Australia 2014). The Academy hopes that the government will make use of the expertise at the NHMRC, and also consult with the sector about how this fund will operate, including detailed consultation with both the university sector and the major medical research institutes.

At this stage, it is difficult to foresee the impact the government's policy on undergraduate fee regulation will have on the sector, on students, and on the economy more broadly. The Academy is concerned that science disciplines will be disproportionately affected by the proposed changes, making science a less attractive option for undergraduates. Whilst the exact outcomes will not be known for some months (or years), modelling has been undertaken that shows student contributions for engineering and science disciplines could increase by 58% from $8,987 to $14,214 (Universities Australia 2014). This is far higher than the average increase across all disciplines which is forecast to increase by 29% from $7,749 to $10,000 (Universities Australia 2014). How the changes to student contributions and the HECS/HELP system will play out is unknown, and there is a risk that in creating new disincentives to study science that this may lead to future skills shortages in the STEM disciplines. It should be noted that fee deregulation has the potential to significant reshape the higher education landscape, as universities adjust their faculty profile to fit in with student demand, rather the research priorities of the nation.

Of particular concern to the Academy are the proposed changes to the postgraduate awards and the introduction of fees to research higher degree students. Fees for research students act as a significant disincentive for students to undertake research degrees and have the potential to significantly reduce the workforce engaged in research in Australia. For a three- to five-year higher research degree program, the imposition of fees for research students, when combined with the proposed increased undergraduate tuition fees and the higher HECS/HELP interest payments, might well prove to be too great a financial burden. Many bright students may see this financial disincentive and compare it with the more favourable economic opportunities in other careers, or undertake postgraduate study and subsequent research careers overseas.

(F) POTENTIAL GOVERNANCE AND FUNDING MODELS FOR AUSTRALIA'S RESEARCH INFRASTRUCTURE AND AGENCIES, AND POLICY OPTIONS TO DIVERSIFY SCIENCE AND RESEARCH FINANCING

National research infrastructure has been on financial life-support for too long. A long-term commitment to investment in both the building and operation of such critically important infrastructure is needed if we are to get the most from our substantial investments in the past, and if we are to carry on undertaking world leading science and research.

It is a major disruption to the sector that many important funding streams such as the Future Fellowship program and the National Collaborative Research Infrastructure Scheme have been non-continuing programs despite their obvious need and substantial benefits. The Academy applauds the government's decision to make the Future Fellowship program a continuing program, and hopes that similar vision can be applied to research infrastructure. Our major national research infrastructure is underfunded and has been at risk of being de-funded, despite the obvious lost sunk costs this would entail, in recent budgets. The National Commission of Audit (2014) emphasised that quality research infrastructure is a critical component of Australia's research and development system (Department of Innovation, Industry, Science and Research 2010), and past reviews have shown the benefits of having a single coordinated approach and funding policy to avoid duplicating infrastructure across the country.

Whilst not a replacement for public investment in research, Australia needs to grow the role of philanthropy within research.

In comparison to the United States, philanthropic donations to universities and research institutes in Australia are low. Universities have been working hard to improve on this, and after many years of sustained effort there has been some very notable large philanthropic donations to universities, such as $65 million to the University of Western Australia, $50 million to the Australian National University, $20 million to the University of Sydney, and $20 million to the University of Technology Sydney. Such donations come after sustained fund raising campaigns. Policy options that encourage universities and research institutes to further develop their philanthropic efforts should be pursued, along with broader policies that encourage philanthropy within the Australian community.

(G) THE EFFECTIVENESS OF MECHANISMS WITHIN AUSTRALIAN UNIVERSITIES AND INDUSTRY FOR DEVELOPING RESEARCH PATHWAYS, PARTICULARLY IN REGARDS TO EARLY AND MID-CAREER RESEARCHERS

(H) POLICY ACTIONS TO ATTRACT, TRAIN AND RETAIN A HEALTHY RESEARCH AND INNOVATION WORKFORCE

Given their overlapping nature the Academy provides a single response to terms of reference (G) and (H).

A House of Representatives inquiry in 2008 found that the three major impediments to attracting researchers to academic careers are the scarcity of opportunities, lack of job security, and uncompetitive salaries (House of Representatives Standing Committee on Industry, Science and Innovation 2008). Since that inquiry, these three major impediments remain, and volatile funding within the sector makes it difficult for employers to invest in new research careers. Australia does need a coherent research workforce strategy that is forward looking and ensures that we have both the research capacity and mix of skills in our research workforce to meet national requirements in the future. We need to map out what is the right amount and balance of awards and fellowships at different career stages. In addition, where appropriate, longer research council grants should be awarded.

Australia is increasingly exposed to intense global competition for skilled workers, and we risk making a considerable investment in training researchers and then losing them to more favourable opportunities overseas (Department of Industry, Innovation, Science and Research 2011). The Government's continued support for the ARC Discovery Early Career Researcher Award (DECRA) is welcome. The DECRA scheme provides an unrivalled opportunity for early career researchers to make the transition from post-PhD into post-doctoral positions and to develop enhanced career pathways by providing a three-year research opportunity. However this program provides funding for only 200 positions across all disciplines and many very talented researchers inevitably miss out. In the 2014 funding round, the ARC received 1,468 DECRA funding proposals, and was only able to fund 13.6% of applications. Of the 200 funded applications, 120 were awarded to resident Australians, 72 to foreign nationals, and eight to returning Australians (Australian Research Council 2014). The Future Fellowship program will in the future provide just 100 mid-career fellowships, down from 200 when the program was first established. These award and fellowship opportunities are vital, and will help Australia attract and retain great researchers. This is an opportune time to review whether Australia has the right balance of fellowships available at different career points.

Universities and public sector research agencies are making increasing use of fixed-term and casual positions and have decreased the proportion of researchers and teachers they employ in continuing positions. This situation is being exacerbated by the volatile funding cycle arrangements for universities and public sector research agencies. Massive and unexpected funding cuts by the previous government and continued funding cuts by this government make it difficult for universities and others to invest in ongoing research positions. Confidence in future income is being undermined by successive governments in pursuing policies of growth and then contraction over short funding cycles. It is harder for employers to invest in long-term career pathways when there is very little confidence in the stability of the funding environment.

There has been less job security for many researchers, particularly for early- and mid-career researchers, with many only employed for the length of the research grant on which they are funded. For many researchers, having spent at least seven years training for a research career, and then engaged in employment, job insecurity pushes them out of research and towards careers with more secure prospects. This represents a considerable waste of talent and investment.

In recent years there has been a range of positive policy initiatives that have made a real difference. The DECRA scheme and having a substantial Future Fellowship program have both helped researchers develop their careers, but both programs are limited in size and duration. In addition, both the ARC and NHMRC have put in place policies within the grant funding application assessment process whereby research personnel are assessed relative to the stage of their career, allowing EMCRs to be more competitive within the application process. Furthermore, recent moves by research councils to offer longer funding periods for grants will result in some longer duration fixed-term contracts for researchers.

Recommended policy initiatives

1. **Review the number of fellowships that Australia provides and ensure that sufficient are being provided at different career levels to provide pathways for career progression.**
2. **Continue assessing ARC and NHMRC grant applications on the basis of excellence relative to opportunity.**
3. **Where appropriate, award research council grants for longer periods of time.**
4. **Grow investment in research steadily and purposefully, with governments avoiding unexpected funding swings which undermine sector confidence and the ability to invest in long-term research career pathways.**

(I) POLICY ACTIONS TO ENSURE STRATEGIC INTERNATIONAL ENGAGEMENT IN SCIENCE, RESEARCH AND INNOVATION

The benefits that come from international engagement in science, research and innovation are immense, and have been outlined on numerous occasions by the Academy and others (Australian Academy of Science 2010; 2011; House of Representatives 2008; Office of the Chief Scientist 2012; Australian Government 2012). In brief, Australia must collaborate with international partners to: (i) give 'critical mass' to its research effort; (ii) ensure our researchers and innovators can contribute to, shape and access the best knowledge available around the world, and then apply it in the national interest; and (iii) leverage intellectual and scientific capital from the considerable investment in science and research that is occurring overseas, particularly in Asia, and use science to support Australia's diplomatic efforts and interests with other nations. In contrast to other nations, Australia has no international science collaboration policy or funding stream to enable such collaboration.

The global scientific landscape is changing, and every year the scientific centre of gravity is moving as nations in our region such as China, Japan, Korea, and India increase their investment in science. China now produces more scientific publications than any other country except the United States, and five of the top 15 nations in terms of scientific output are in Asia (Scimago 2014). Japan has overtaken the United States to become the highest producer of triadic patent families (OECD 2012).

Despite having approximately 0.3% of the world's population, Australia produces 3% of the world's scientific output, and is ranked 12th in terms of scientific output when measured by number of publications produced. Australian scientific output is of high quality, receiving a very high number of citations per article (Scimago 2014). Successive quality assurance exercises have shown Australian science to be of high quality (for example see Australian Research Council 2012). The high quality of our science means that Australia is well positioned

to be a partner of choice in international science collaboration endeavours, but this important area of government policy needs to be significantly strengthened.

Successive Australian governments, and governments around the world, have recognised the clear benefits that international collaboration in science and research brings. The previous government recognised this through its policy work and in its statements (for example see DIISTRE 2013; Australian Government 2012; 2013). The international scientific linkages program established under the Howard government was ended in 2011, and only a couple of much smaller country-specific collaboration programs were established in their place. International scientific collaboration is a competitive undertaking and much of the rest of the world is actively pursuing policies to internationalise their national research effort and to collaborate with nations investing heavily in science. The United Kingdom has recently announced a five-year £375m fund for international science partnerships (see Department for Business, Innovation and Skills 2014). The European Union's Horizon 2020 is an €80 billion international research endeavour, with collaborations being developed well beyond the European Union. Australia must leverage its considerable intellectual talent so it is able to take advantage of and participate more fully in international science collaboration.

Investing in international science collaboration should not be seen as an additional investment on top of government investment in science. It must be seen as an essential component that is required to ensure we are able to get maximum value from our existing science investment. The Australian government invests around $8 billion each year in science, research and innovation, and a proportion of this investment must focus on the internationalisation of Australia's research endeavours.

(J) POLICY OPTIONS TO CREATE A SEAMLESS INNOVATION PIPELINE, INCLUDING SUPPORT FOR EMERGING INDUSTRIES, WITH A VIEW TO IDENTIFYING KEY AREAS OF FUTURE COMPETITIVE ADVANTAGE

Productivity is the efficiency with which an economy transforms its inputs such as capital and labour into outputs such as goods and services. Productivity growth means that a nation is producing more goods and services for the same quantity of labour, capital, land and energy (Australian Bureau of Statistics 2012). Increased productivity is seen as generating higher incomes and improved living standards. Australia's market sector multifactor productivity grew at an average 0.2% in the 2000s compared to 1.4% in the 1990s (Eslake 2011). Since 2004–05, multifactor productivity has recorded negative growth in most years (Australian Bureau of Statistics 2012). As the Minister for Industry has rightly pointed out, Australian productivity relies on innovation (Macfarlane 2014); if Australia is to raise its productivity then it has to innovate.

Lifting productivity growth must be seen as a critical priority for Australia and innovation is a key driver of productivity growth. However Australia's innovation performance has not kept pace with the rest of the world. In 2013 Australia has slipped out of the top 20 in the World Economic Forum's Global Competitiveness Index (21st position) for the first time, having been 5th in 2002 (World Economic Forum 2014). The Australian Council of Learned Academies (ACOLA), of which the Australian Academy of Science is one of the four member Academies, has recently undertaken a substantial study to examine how investment in and application of science, research and technology can enhance creativity and innovation to lift productivity in Australia. The report has three main conclusions:

(i). Building Australia's future industries will depend on adopting technological innovation to develop high-value products and services for a global market.

(ii). Improving collaboration in Australia, between businesses and between business and publicly funded research, will significantly enhance innovation. International collaboration is also critically important. Both domestic and international collaboration improves the productivity and competitiveness of Australian technology-based firms.

(iii). An innovative workforce that combines technical and non-technical disciplines, and enables good business management, is essential to underpin the competitive advantage of Australian industries and realise opportunities to lift productivity.

(Bell et al 2014)

The report goes on to outline a number of areas where urgent action is needed, and a copy of this report is attached to the Academy's submission to assist the inquiry in developing policy options to improve the innovation pipeline in Australia.

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