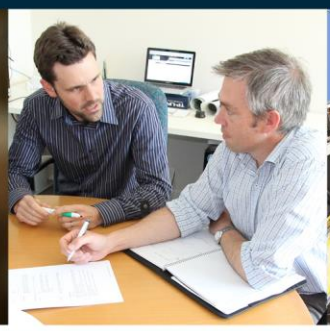
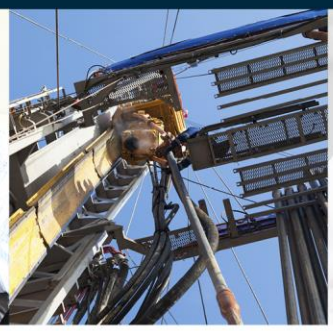
Australian Government
Department of Education

Australian Government
Department of Industry

Boosting the commercial returns from research

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Introduction

As a key, business-focused element of the Economic Action Strategy, the Industry Innovation and Competitiveness Agenda brings together and builds on the Government's other economic reform efforts to make the most of Australia's strengths and business opportunities.

Through the Competitiveness Agenda, the Government aims to achieve four overarching ambitions:

1. A lower cost, business friendly environment with less regulation, lower taxes and more competitive markets;
2. A more skilled labour force;
3. Better economic infrastructure; and
4. Industry policy that fosters innovation and entrepreneurship.

Better translation of research into commercial outcomes is a key part of this and will help drive innovation in Australia, grow successful Australian businesses and research capacity, and boost productivity and exports. It aligns with the Government's measures to reform the higher education sector and to realise the potential of health and other research.

The Government is keen to consult the research and business communities and other interested parties on how best to achieve this, and invites responses to the issues and options raised in this paper.

1. Improving Australia's economic performance through better translation of research into commercial outcomes

Australia's research activities are conducted through universities, publicly funded research organisations, private research organisations and innovation-active businesses.

Overall, the sector is highly productive, internationally connected, and recognised globally for high quality research. For example, in 2013 we contributed to 3.9 per cent of the world's research output (in terms of publications) from 0.3 per cent of the world's population, ranking 9th in the OECD. Our research sector is also building on this strength and has improved its share of the top 1 per cent of publications from 3.8 per cent in 2004 to 6.7 per cent in 2013 (measured by relative citation impact).[1]

Our publicly funded research agencies, such as the CSIRO, are mission-directed, and tend to have a focus on generating commercial outcomes. Our universities serve the national public interest in many ways, including by generating new ideas that have long-term implications, and by producing focussed research that, for example, contributes to better public health and wellbeing.

Australia performs strongly on research excellence, but we perform poorly by international standards in translating publicly funded research into commercial outcomes.

This is evident in the comparison of innovation inputs (including research), with innovation outputs using the Global Innovation Index Innovation Efficiency Ratio, in which Australia ranks 81st out of 143 countries.[2] On a different measure, non-residents filed 90 per cent of patents in Australia in 2012.[3]

One reason Australia has difficulty capitalising on its public investment in research is the insufficient transfer of knowledge between researchers and business.[4] This is illustrated below:

- Australia ranks 29th and 30th out of 30 OECD countries on the proportion of large businesses and small to medium enterprises (SMEs) collaborating with higher education and public research institutions on innovation.[5]

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[1] Incites™,Thomson Reuters (2014), Benchmarking Report, generated September 2014.
[2] Cornell University, INSEAD, and WIPO, *The Global Innovation Index,* 2014.
[3] World Intellectual Property Organisation, *World Intellectual Property Indicators*, 2013.
[4] T Cutler, *Venturous Australia*, Review of the National Innovation System, 2008; Productivity Commission, *Public Support for Science and Innovation*, 2007; ATSE, *Strengthening Links Between Industry and Public Sector Research Organisations*, 2011.
[5] OECD, based on Eurostat (CIS-2010) and national data sources, June 2013: http://dx.doi.o rg/10.1787/888932891359.

- The proportion of Australian researchers working in business (as opposed to the public research sector) is significantly lower in Australia than in other countries. This is exacerbated by the low levels of mobility between the two sectors.[6]
- Australia ranks 23rd out of 32 countries on the percentage of total research publications that are co-authored by industry and the research sector.[7]
- Australia ranks second last of 17 OECD countries on new-to-the-world innovation, which is partly attributed to Australian businesses' preferences to instead adopt or modify existing innovations.[8]

Improving the translation of research into commercial outcomes will help drive innovation in Australia, grow successful Australian businesses, and boost productivity and Australia's exports, ensuring the competitiveness of the Australian economy into the future.[9]

This paper examines the factors that support translation of public research into commercial outcomes and how Australia compares against these factors. A range of measures is then proposed to ensure Australia is well-positioned to reap the economic benefits of research in the longer term.

[6] Department of Innovation, Industry, Science and Research (DIISR), *Research Skills for an Innovative Future*, 2011.
[7] OECD, *Commercialising Public Research: New Trends and Strategies*, 2013.
[8] DIISR, *Australian Innovation System Report*, 2011.
[9] Productivity Commission, *Annual Report*, 2007-08.

2. Factors that support the translation of public research into commercial outcomes

Countries that successfully translate their research into commercial outcomes tend to exhibit the following four factors in their research and innovation systems: research excellence, targeted research effort, cooperation between research and industry, and entrepreneurship.[10]

A. Research excellence

High quality research is a driver of innovation. It is driven by and supports talented people.[11] It generates international linkages. It yields more breakthroughs and provides new ideas for business. The United Kingdom (UK) and United States (US), which are in the top six in the 2014 Global Innovation Index report, also ranked in the top three for research quality.[12]

Factors known to drive national research excellence are world-class infrastructure, a highly skilled research workforce, critical mass in areas of research strength and international research engagement.[13] Stable, predictable funding over the long term is also important for a high performing national research sector.[14] Industry engagement can also be a driver of research excellence.[15]

B. Targeted research effort

Many countries (including Germany, the UK, New Zealand, Canada and Denmark) focus research on current and emerging strengths, and areas of national importance. Indeed, almost all countries in the OECD have a long-term national science and research investment policy.[16]

In the European Union (EU), increasing fiscal pressures have driven a trend towards setting strategic research priorities to establish national technology strengths, which in turn drive innovation. Member states have used a combination of different criteria when deciding how to target their research

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[10] See e.g., OECD, *Commercialising Public Research: New Trends and Strategies,* 2013; Market Line, *Switzerland*, Country Profile Series, 2013; P Lundequist and A Waxell, 'Regionalising "Mode 2"? The adoption of Centres of Excellence in Swedish research policy', *Geografiska Annaler: Series B, Human Geography*, Vol. 92, Issue 3, 2010.
[11] Economic Insight, *Growing the best and brightest: The drivers of research excellence,* 2014.
[12] Cornell University, INSEAD, and WIPO, *Global Innovation Index*, 2014. SCImago, *SJR SCImago Journal & Country Rank*, http://www.scimagojr.com/countryrank.php.
[13] Department of Industry, Innovation, Science, Research and Tertiary Education (DIISRTE), *National Research Investment Plan,* 2012,.
[14] OECD, 'Public Sector Research Funding', *Innovation Policy Platform Issue Brief*, 2011; DIISRTE, *National Research Investment Plan*, 2012.
[15] OECD, *Commercialising public research: New trends and strategies*, 2013.
[16] Office of Australia's Chief Scientist, 2014.

effort, including dialogue with industry on emerging technology needs and with the community on national societal challenges. In most EU countries, national governments have led this dialogue.[17]

For example, the German government set priorities for its national innovation system through its *High-Tech Strategy 2020*. The German strategy focusses on improving conditions for innovation by addressing challenges in the fields of climate/energy, health/nutrition, transport, safety and communication. Indicators suggest the strategy has been successful, with a 19 per cent increase in R&D investment by industry (from 2005 to 2008), a 12 per cent increase in R&D personnel (from 2004 to 2008), an increase in R&D intensity to 2.7 per cent of GDP (by 2008), and a high proportion (30 per cent) of German businesses attributing their innovations to improved federal leadership under the High-Tech Strategy.[18]

C. Cooperation between researchers and industry

Collaboration between the research sector and business is crucial for innovation. Internationally, innovation has flourished in locations where researchers and industry have come together, such as Silicon Valley and the Cambridge Science Park. The Cambridge Science Park is built on the foundation of scientific research undertaken at the University of Cambridge and features firms in sectors such as electronics, computing, software, scientific instruments and pharmaceuticals. Today, it includes 1,400 firms, which employ over 53,000 people and turn over £13 billion a year.[19]

In many countries, including Australia, there is a role for intermediaries to help connect research and business. These intermediary services may be provided by universities, publicly funded research agencies, research infrastructure providers or third parties. Often the focus is on supporting the experimental development required to make a discovery commercially viable, so it can then attract private capital. Examples of other countries using third party intermediaries include Germany's Fraunhofer Institutes, the UK's Technology Strategy Board and Catapult Centres, and the Netherlands Organisation for Applied Scientific Research(TNO).[20]

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[17] European Commission, *Research and Innovation Performance in EU Member States and Associated Countries,* 2013, .
[18] Federal Ministry of Education and Research, *High-Tech Strategy 2020 for Germany*, 2010.
[19] J Silver, 'Cambridge: The UK's first tech city', *Informilo*, 2 March 2013, http://www.informilo.com/20130302/cambridge-uks-first-tech-city-769.
[20] Technology Strategy Board, *Catapult Programme: Progress Update 2012-2013*, August 2013.

D. Entrepreneurship

Countries that excel in innovation tend to exhibit a high degree of entrepreneurship in both the research community and industry.[21] This is partly a function of market drivers, and cultural and historical factors. However, regulatory settings and access to finance can support or hinder entrepreneurial activity. Countries such as the US, the UK and Sweden have more supportive environments for start-ups and entrepreneurial risk-taking, including taxation arrangements for employee share schemes, bankruptcy laws that do not disproportionately penalise business failure, initiatives to improve access to funding, and clearly-defined Intellectual Property (IP) rights regimes coupled with pro-competition policies, to incentivise firms' uptake of knowledge-based capital.[22]

For example, in 2011, following the Global Financial Crisis, the UK Government announced the *Plan for Growth*, which included an ambition to make the UK the best place in Europe to start, finance and grow a business. During a tight fiscal period, the *Plan for Growth* funded programmes to encourage private sector investment in small innovative businesses, such as the Business Angel Co-Investment Fund.[23]

In the university setting, generous pecuniary benefits for commercialisation can tilt the incentive structure in favour of researcher entrepreneurship. The University of Cambridge's IP licensing arrangement—where net income for the first £100,000 is directed to the researchers at a rate of 90 per cent—provides an example of this.[24]

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[21] Cornell University, INSEAD, and WIPO, *Global Innovation Index Report,* 2013.
[22] OECD, *Raising the Returns to Innovation: Structural Policies for a Knowledge-Based Economy*, 2013.
[23] OECD, *Policies for seed and early stage finance: Findings from the 2012 OECD Financing Questionnaire* , 2013.
[24] Cambridge Enterprise, *Inventions, IP and licensing,* 2014, http://www.enterprise.cam.ac.uk/university-community/inventions-ip-licensing/revenue-sharing/.

3. How does Australia compare?

Australia's research and innovation system is positioned in an environment characterised by: the small size and geographical dispersion of our population; remoteness from key markets; and a predominance of enterprises that, without any changes to our current settings, are more likely to be modifiers and adopters of innovation and technology than developers in their own right.

A. Research excellence

Australia's research output (in terms of publications and citations) ranks highly in the OECD on indicators of research quality.[25] For example, in 2013 we contributed to 3.85 per cent of the world's research output (in terms of publications) from 0.3 per cent of the world's population, ranking 9th in the OECD. Research by Australian universities is rated as well above world standard in a range of disciplines, including chemistry, biology, the health and medical sciences, and within certain areas of the humanities, arts and social sciences.[26]

Australia's research system is reasonably well funded by international standards. Australia ranks 11th out of 34 OECD countries in gross R&D expenditure as a percentage of GDP, and 9th in expenditure by the higher education sector.[27] In 2014-15, spending on Australia's publicly funded research system is forecast to include:

- $2.7 billion for competitive research grants and other research support
- $1.9 billion through performance based block funding
- $2.4 billion for the R&D Tax Incentive
- $1.8 billion for Australian government research activities

Australia's funding of its research sector has historically been relatively stable, which has helped to drive its strong international performance in research excellence.[28] However, uncertainty around funding for fundamental components of the research sector, including stop-start funding of the National Collaborative Research Infrastructure Strategy (NCRIS), may have

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[25] Because our system is geared towards excellence it has worked very well in creating an internationally renowned and high-performing Australian research sector. See L Butler, 'Impacts of performance-based research funding systems: A review of the concerns and the evidence', in *Performance-based Funding for Public Research in Tertiary Education Institutions: Workshop Proceedings*, Chapter 4, OECD, 2010, http://www.oecd.org/document/25/0,3746,en_2649_37437_46622745_1_1_1_37437,00.html.

[26] ARC, *ERA National Report*, 2012,.

[27] Department of Industry, *Australian Innovation System Report,* 2013. On business expenditure on R&D (as a percentage of GDP), Australia ranks 13th in the OECD, and on government expenditure on own research, including Publicly Funded Research Organisations such as CSIRO, we rank 12th in the OECD.

[28] ABS, *Research and Experimental Development, Government and Private Non-Profit Organisations, Australia*, 8109.0, 2011-12.

reduced the sector's productivity and risked affecting our research excellence over the long-term.[29] The 2014-15 Budget committed $150 million to the continuation of the NCRIS for 2015-16 and commissioned a reassessment of existing research infrastructure provision and requirements to inform ongoing funding for research infrastructure. The recently announced Medical Research Future Fund will bolster medical research funding. With target capitalisation of $20 billion by 2020, the fund will roughly double the Government's direct contributions to medical research by the early 2020s. The new fund can also deliver the translation fund to leverage private sector finance and capabilities recommended in the 2013 *Strategic Review of Health and Medical Research* ('the McKeon Review').[30]

B. Targeted research effort

Australia's research effort is focussed in key sectors relevant to our economy and society and has a strong bias towards applied research. In 2012, seventy six per cent of publicly funded higher education research was on strategic basic, applied and experimental research versus 24 per cent on pure basic research.[31] This is a result of the conscious investment choices of government, as well as the cumulative results of competitive grant outcomes.

Publicly funded research organisations have a major focus on medical and health sciences (25 per cent), engineering (11 per cent) and biological sciences (9 per cent). [32] The emphasis on health sciences will grow further as the Medical Research Future Fund grows. Private sector R&D is focussed on engineering (47 per cent) and information and computing sciences (30 per cent).[33] The largest contributors to business R&D expenditure in 2011-12 were the manufacturing, mining and financial and insurance services sectors.[34]

These areas of focus have received considerable funding over time and currently represent areas of research strength. For example, Australian research into clinical medicine performs above the world average and represents 20 per cent of the total Australian research output.[35] Australia's substantial public investment in medical research has yielded commensurate

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[29] B Schmidt, 'Research needs guarantees for long-term investment', *Australian Broadcasting Corporation*, 13 August 2013; B Schmidt and P Doherty, 'Research will dry up without funding stream', *The Australian*, 19 June 2013.
[30] Department of Health and Ageing, *Strategic Review on Medical and Health Research*, 2013, http://www.mckeonreview.org.au/9903/Home/.
[31] ABS, *Research and Experimental Development dataset*, 2012 Higher Education Organisations, Australia.
[32] ABS, *Research and Experimental Development dataset*, 2012-13 for Government expenditure and 2012 for higher education. In order to examine expenditure by publicly funded research organisations, the higher education and government datasets have been combined.
[33] ABS, *Research and Experimental Development, Businesses, Australia, 2011-12,* 8104.0, by fields of research.
[34] ABS, *Research and Experimental Development, Businesses, Australia, 2011-12,* 8104.0, by ANZSIC06 industry subdivision.
[35] Incites™,Thomson Reuters (2014), Benchmarking Report, generated September 2014.

public benefits, and broadly speaking, Australians enjoy some of the best health outcomes in the world. Meanwhile, Australian research in engineering performed equivalent to the EU15 on field weighted citation impact between 2002 and 2012.[36]

However, despite our many research strengths, many are questioning whether our research activities are answering the most pressing questions for Australia, including our economic imperatives. The Chief Scientist recently emphasised the need "to make sure we're doing all the things that we need to do well."[37] The Chief Scientist also recognises the need for science, technology, engineering and mathematics to work in tandem with the critical areas of social sciences and humanities.[38]

Similarly, in medical research, the McKeon Review recommended that medical research be prioritised towards areas of high impact (both health and economic). This is not a straightforward task given that medical research is often undertaken in the course of treating patients in clinical settings, and can also involve the provision of clinical teaching and supervision. While the consequent blurring of the boundaries between treatment, research and education can present challenges for prioritisation of research, this effort could nonetheless potentially improve national health and wellbeing, and reduce the financial burden from the acute end of the health system.[39]

[36] Office of the Chief Scientist, 2014.
[37] ABC Lateline interview, 2 June 2014.
[38] Office of Australia's Chief Scientist, *A Science, Technology, Engineering and Mathematics Capability Strategy for Australia*, 2014
[39] Department of Health and Ageing, *Strategic Review on Medical and Health Research*, 2013, http://www.mckeonreview.org.au/9903/Home/.

Opportunity to assure Australia's research focus

The Government is in a position to develop national research priorities and, for each priority, corresponding practical challenges to provide assurance that public research is addressing the most important questions for the nation.

The Chief Scientist is currently preparing a set of draft research priorities for consideration by the Commonwealth Science Council. These could be the starting point for a series of expert discussions between industry, research organisations and government to further detail specific research priorities. The priorities should take into account areas of current and future research excellence, industrial strength, global trends and community interests.

These priorities and practical challenges could first be used to take stock of existing research effort. Any gaps in existing research could be addressed through targeted investment in relevant programmes or institutions. The nature of specific investments would be determined by the circumstances of a particular priority area. For example, the Government could make a specific investment in a research topic, such as the recent initiative around dementia research.

Alternatively, a research priority could be strengthened through the criteria for competitive grants. The assessment of gaps could also guide the development of a long-term infrastructure roadmap.

C. Cooperation between researchers and industry

While there are some good examples of research-industry collaboration in Australia, collaboration between Australian researchers and industry is inadequate and falls well short of international benchmarks.[40]

Australia ranks 29th and 30th out of 30 OECD countries on the proportion of large businesses and SMEs collaborating with higher education and public research institutions on innovation.[41] A distinctive feature of global economic integration is the increasing rate of innovation engagement with foreign partners—Australia performs poorly on international collaboration on innovation by firms, ranking 26th in the OECD.[42]

One of the contributing factors to poor collaboration is the higher proportion of our researchers working outside of business than in comparable countries.

[40] The health services sector is an exception. Health care in itself is a significant service industry and historically collaboration between hospitals and universities has provided opportunities for much of health and medical research to be undertaken in the health services sector.
[41] OECD, based on Eurostat (CIS-2010) and national data sources, June 2013: http://dx.doi.org/10.1787/888932891359.
[42] International collaboration on innovation by firms, 2008-2010. Australia is ranked 26th of 30 countries in the report, however three countries listed (Russian Federation, South African and Brazil) are not OECD members: OECD, *Science, Technology and Industry Scoreboard*, 2013.

Sixty per cent of Australian researchers are employed by the higher education sector, compared to around 30 per cent in Germany, Canada and Sweden.[43] The UK has a similar mix to Australia, but achieves far better results on measures of collaboration and innovation.[44]

There are some good examples of research-industry collaboration in Australia, particularly where there has been dedicated investment in organisations that have an industry or collaboration focus. For example, the CSIRO works with around 3,000 clients each year, including more than 20 per cent of the ASX top 200 companies and 1,300 SMEs. The long running Cooperative Research Centres (CRCs) programme links researchers with business and other end users across a range of sectors. The Government recently announced the start of an independent review to ensure the programme is making appropriate and effective investments in collaborative projects that will boost Australia's productivity and international competitiveness.

NHMRC Development Grants encourage specific collaboration between universities and industry. In the health and medical research sector both universities and the network of non-government medical research institutes (MRIs) have a good record of conducting research in collaboration with hospitals with positive results. Examples include the University of Queensland's work in developing Gardasil (the human papillomavirus vaccine) and the George Institute's collaboration with the University of NSW which led to changes in fluid replacement treatments for critically ill patients around the world.[45]

Australia's 15 rural research and development corporations (RDCs) are another good example of research-industry collaboration. These organisations are funded as government-industry partnerships. Primary producers pay a levy on their production to contribute to collective R&D for their industry sector, and the Australian Government contributes matching funding up to a capped level. Research by the Australian Bureau of Agricultural and Resource Economics and Sciences has found that for every dollar the government invests, farmers generate around 12 dollars within 10 years in terms of increased agricultural productivity.

Despite such examples, the evidence suggests that both Australian industry and the research sector could do better. On the business side, there are low

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[43] OECD, *Science Technology and Innovation Scoreboard*, 2013.
[44] Office of Australia's Chief Scientist, 2014; UK is ranked 2nd in the Global Innovation Index 2014, and close to a third of large firms collaborate with higher education or public research institutions according to the OECD, *Science, Technology and Industry Scoreboard*, 2013.
[45] SAFE study investigators, 'A Comparison of Albumin and Saline for Fluid Resuscitation in the Intensive Care Unit', *New England Journal of Medicine*, 2004, http://www.nejm.org/doi/full/10.1056/NEJMoa040232#t=abstract.

levels of industry collaboration with the research sector by firms of all sizes.[46] For example, only 3 per cent of Australian businesses involved with innovation activity sourced their ideas from universities or higher education institutions compared to 59 per cent who sourced their ideas for innovation from within the business or company.[47] Only 9.7 per cent of innovative businesses had collaborative arrangements with universities and higher education institutions.[48]

Even amongst innovation-active businesses, barriers to innovation itself are significant and can affect the degree to which new ideas or information are sought. Reported barriers include uncertain demand for new goods or services, government regulations and compliance, cost of development or implementation, lack of access to additional funds, and lack of skilled persons. In the health sector, which is among the most innovative Australian research sectors, the McKeon Review noted that successful translation of research requires further business capabilities in development, production and distribution. The review also identified the potential for better links between research and the delivery of healthcare services.[49]

Australia has a large number of SMEs and, in common with other OECD countries, a high proportion of firms in low to medium technology industries, such as services.[50] Without any imperative for change, these firms are less likely to have the capacity to engage directly with university research and integrate it within their operations.

A lack of person-to-person and institution-to-industry links can prevent knowledge, skills, and resources from being shared. Organisations with the specific purpose of translating and transferring technological development into industry practice can help establish these links, and this activity can be encouraged by government. At present, outside of a few sectors—such as mining and agriculture—Australia does not have organisations of this type at the scale of more highly ranked innovating countries including the UK, the Netherlands and Germany.[51]

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[46] OECD, *Science, Technology and Industry Scoreboard*, 2013.
[47] ABS, *Innovation in Australian Business*, 8158.0, 2012-2013: This percentage reflects only direct knowledge transfer from higher education institutions. It is not possible to identify indirect flows of knowledge between the research sector and business, although it should be noted that 27.1% of Australian businesses reported sourcing ideas from 'websites, journals, research papers or publications'.
[48] ABS, *Innovation in Australian Business*, 8158.0, 2012-2013.
[49] Department of Health and Ageing, *Strategic Review on Medical and Health Research*, 2013, http://www.mckeonreview.org.au/9903/Home/.
[50] K H Smith and J West, *Australia's Innovation Challenges: Building an Effective National Innovation System*, 2005; A Arundel and K R O'Brien, 'Innovation Metrics for Australia', *Innovation Metrics Framework: Consolidated Report*, DIISR, 2009.
[51] E Webster, Proposal for Industry-Led Innovation Consortia, 2014; for example, see the Catapult Centres in the UK, the Dutch 'TTI' and 'MTI' brokerage organisations and the Fraunhofer Institutes in Germany: Department of Industry, Tourism and Resources, *Study of the Role of Intermediaries in Support of Innovation*, 2007, http://www.innovation.gov.au/innovation/reportsandstudies/Documents/InnovationIntermediariesReport.pdf; Office of the Chief

Opportunities to support collaboration

Part ofthe Government's Entrepreneurs' Infrastructure Programme, the Research Connections element is focused on helping small and medium businesses to identify any knowledge gaps that are preventing business growth and develop new ideas with commercial potential. Research Connections takes a facilitation-first approach, providing expert advice and solution pathways for business to knowledge-related issues, and a brokering service to link businesses with research organisations. Research Connections can also provide a matched funding grant of up to $50,000 for two to 12 months, which can be used to employ a researcher or otherwise develop a collaboration with the research sector aligned to business needs.

The Government can also play a light-touch connecting role by providing research equipment that is nationally significant and ensuring that it is widely accessible. This can draw business, researchers and related industries together to access the technology. This has occurred with some facilities funded under the NCRIS. For example, the Australian National Fabrication Facility provides nano-fabrication facilities that support a range of industrial and academic research, helping projects transition into spin-out companies.[52] Investments under the NCRIS have provided services to over 30,000 users, leveraged co-investment totalling $1.02 billion, and provided the basis for collaboration across the Australian research system and with researchers in 29 countries.

The Government can also provide businesses with research information, through initiatives such as a single online access point and mandating open access to publicly funded research.

Universities are strongly motivated to direct their research activities towards academic excellence, as this is the internationally recognised measurement of university performance. It is also an important factor in university income from research block grants, Australian Research Council (ARC) and NHMRC competitive grants, international student intake, and rankings through the ARC's Excellence in Research Australia (ERA) initiative.[53] Industry experience and past success in solving industry problems are not generally part of the metrics of academic excellence.

Scientist, 'Information Brief: UK Technology Strategy Board (TSB)', 16 April 2014; UK Government Department for Business, Innovation and Skills, Technology Strategy Board, *Triennial Review*, October 2013; Rathenau Instituut, 'The Dutch science system: TTIs and MTIs', http://www.rathenau.nl/en/web-specials/the-dutch-science-system/organisations/ttis-and-mtis.html.

[52] Australian National Fabrication Facility (ANFF), *Providing Solutions…A Casebook*, 2012, http://www.anff.org.au/case-studies/anff-providing-solutions-casebook.pdf; ANFF, *Building Competitive Advantage: A Casebook*, 2013, http://www.anff.org.au/anff-2013-casebook.pdf.

[53] In 2012, the top five Australian universities by international student enrolment were also the top five recipients of Research Block Grants and Australian Competitive Grants.

Australian universities are highly responsive to incentives, including non-pecuniary ones like institutional prestige. This is illustrated by the large structural changes many Australian universities made in response to the ERA, which influences a small proportion of funding.

Opportunities to reshape research grant incentives

Getting the right incentives in place to encourage collaboration will set a long-term direction for the research sector that will deliver greater commercial returns.

Block grants for Australian universities should retain a focus on quality and excellence and should be adjusted to place added emphasis on research-industry collaboration. Such changes may improve the proportion of university research relevant to industry and encourage greater mobility between sectors.

Competitive grant bodies, including the ARC and NHMRC, could be required to recognise industry experience as a complement to research excellence (as defined by existing metrics such as publication and citation rates).

While researchers in the health and medical sector can move between research organisations and industry, more broadly there are significant career mobility constraints for researchers wishing to move between the different sectors.[54] As well as a lack of reward and recognition in universities for skills and knowledge developed within industry, there is uneven focus on arranging industry internships for doctoral students, placing early career researchers into industry on secondment, and circulating staff between SMEs and universities.[55]

Currently, most PhD programmes place limited focus on the skills and training—such as IP awareness, business management and entrepreneurship—that would facilitate later industry employment for researchers with no prior industry experience.[56] While not appropriate for all PhD students, there is room to do significantly more in this area for those who may not remain in academia.

[54] DIISR, *Research Skills for an Innovative Future: A Research Workforce Strategy to Cover the Decade to 2020 and Beyond*, 2011, .
[55] Advice received from the University of Melbourne.
[56] R K Shepherd, 'Culture shift required: Improving the economic impact of Australian research', *Australian Quarterly*, Jan-Mar 2014.

Opportunity to ensure graduate industry skills

The Government has an opportunity to reform research training arrangements, including scholarships, to ensure that, in relevant disciplines, universities are producing graduates with business, management, and entrepreneurial skills.

Time and difficulty negotiating IP contracts can also deter businesses trying to collaborate with Australian research organisations. IP contracts typically take 10 months to negotiate. Common problems in the negotiation process include agreeing which parties own project IP, publication rights, and accurate valuation of the IP.[57] Information on options to improve IP arrangements is provided below.

D. Entrepreneurship

Evidence shows that Australian business has a low incidence of new-to-market or radical innovation.[58] This proportion is significantly less than in many other OECD countries. It is generally agreed that this form of innovation is closely linked to research-to-business collaboration.

Access to finance is reported as a significant challenge for Australian innovation-active firms.[59] The shortage of funding can occur at various stages through the commercialisation process. However early stage financing to get past the 'valley of death' funding gap—that is, the proof of concept and prototyping stages between research and positive cash flow—is crucial to success. This is particularly an issue for radical innovations that may arise from public research and can have a significant impact on realising economic returns from the Government's research investment.[60]

Evidence of this funding gap is that the Australian early stage venture capital market is well below the OECD median as a percentage of GDP, at 0.009 per cent.[61] To undertake radical innovation, firms need advanced capabilities in a range of areas such as finance, business strategy and human resource management. Many Australian businesses, particularly SMEs, lag behind international best practice in these areas.[62] A key message from industry is that greater regulatory and policy certainty would improve business confidence in innovation investment. Framework conditions such as

[57] Advisory Council on Intellectual Property, *Collaborations between the Public and Private Sectors,* 2012,.
[58] DIISR, *Australian Innovation System Report*, 2011.
[59] OECD, *Science, Technology and Industry Scoreboard*, 2013.
[60] G Ford et al, *An Economic Investigation into the Valley of Death In the Innovation Sequence*, 2007.
[61] Department of Industry, *Australian Innovation System Report,* 2013,.
[62] R Green, *Management Matters in Australia: just how productive are we?,* 2009.

macroeconomic policy settings, labour market regulation and competition policy have a significant impact on innovation.[63] Rules around directors' liability, crowd-sourced equity funding, bankruptcy, and taxation of employee share schemes and early stage investments have been raised by industry stakeholders as impediments to investing in innovative firms.[64]

The Industry Innovation and Competitiveness Agenda responds to these concerns and announced changes to employee share scheme arrangements, reversing the changes made in 2009 to the taxing point for options, while retaining the integrity provisions that were introduced at that time. A further concession will also be made available to eligible start-ups, which will allow them to issue to their employees options under certain conditions or shares at a small discount, and have taxation deferred until sale or the small discount exempt from tax. The Treasurer will consult with industry to ensure that the draft legislation delivers the intended outcome, with the legislation intended to come into effect for shares or options provided from 1 July 2015.

Burdensome regulation can obstruct home-grown entrepreneurship and the uptake of research in Australia. For example, Australian manufacturers of medical devices are required to have their device approved by the Australian Therapeutic Goods Administration (TGA) if they supply them in Australia, even if it has already been approved by a European regulator. By comparison, European manufacturers that have their devices approved to be sold in Europe do not require TGA approval to supply them in Australia. Therefore, innovative medical device companies manufacturing in Australia face greater regulation in Australia than their European counterparts.[65]

While a number of previous business innovation programmes have been successful, they lacked scale. The only programme of significant size has been the R&D Tax Incentive. However, the Government has provided $484.2 million over five years from 2014-15 to establish the Entrepreneurs' Infrastructure Programme, with delivery through a streamlined Single Business Service Initiative. It provides strategic support to businesses, bringing research and business together to commercialise ideas and equipping small and medium firms with the management and business skills to change and expand. The Industry Growth Centres Initiative (the Initiative), a key element of the Government's Innovation Industry and Competitiveness Agenda, will encourage greater productivity and competitiveness at the sector level where economic growth can be maximised. The Initiative will focus on

[63] Productivity Commission, *Annual Report*, 2007-08.
[64] Australian Government consultations with industry stakeholders, including through the Financial System Enquiry, the Review of Crowd Sourced Equity Funding and consultations for employee share schemes.
[65] Information from the Medicines Strategic Red Tape Review, May 2014.

growth sectors within the Industry Portfolio: (1) food and agribusiness, (2) mining equipment, technology and services, (3) oil, gas and energy resources, (4) medical technologies and pharmaceuticals, and (5) advanced manufacturing.

The Initiative will boost the productivity and competitiveness of these key sectors through increasing commercialisation, enhancing workforce skills, reducing regulatory burden, forging closer links with supply chains to increase export growth and investment, and driving business to business and researcher collaboration through sector-wide projects. Positive flow-on benefits will also occur to other critical sectors, such as services and information and communication technology (ICT).

The Initiative will commence a staged roll-out from early 2015 with Centres to be led by respected industry leaders. The Initiative is flexible in its delivery to ensure each sector can implement its solutions to the impediments to success. It also provides the long term capability and underpinning infrastructure required for the five growth sectors to be self-reliant and thrive.

The Initiative also includes an additional $60 million to address sector-wide impediments to accessing early stage finance for commercialisation. High potential projects to prove market potential, attract private sector investment and bring new ideas to market will be eligible. This element will be delivered through the Entrepreneurs' Infrastructure Programme.

Opportunities to encourage innovation by Australian businesses

The R&D Tax Incentive has been one of the Government's most significant levers for encouraging business innovation. This is expected to be reviewed in the context of the forthcoming Tax White Paper. The review offers an opportunity to consider the effectiveness of the programme in incentivising companies to undertake activities that are likely to deliver economy-wide benefits that would not be enjoyed in the absence of public support. While the primary objective of the R&D Tax Incentive is to address market failures in R&D conducted by business, the Government should also look at the scope for the programme (or an alternative mechanism) to encourage collaboration with research institutions.

The Industry Growth Centres Initiative will bring industry together with publicly funded research organisations, the university sector and science to better work together, increasing innovation opportunities and providing a framework to transition industry to products and services that are high-value added. The Initiative is industry led, which will also help create more of a 'demand-pull' for research.

While Centres will adopt different approaches to tackle each individual sector's impediments to success, overarching activities applicable to all sectors include the development of a sector competitiveness plan, a regulation reform plan and annual industry knowledge priorities to inform the research sector of industry needs and commercialisation opportunities.

A $63 million Growth Centre Project Fund (Fund) will be established to enable large-scale innovative projects focused on collaboration, research translation and business to business linkages. Initial projects commence in 2015-16 with projects ramping up as sectors demonstrate capacity. Projects will require a minimum matched contribution from industry participants, and be required to have significant sector wide impact.

Currently Australia ranks lower than the US, Europe, Canada and the UK on the number of public research spin-off companies per US $100 million of research expenditure.[66] This suggests a lack of entrepreneurial culture within research organisations. To encourage Australian researchers to drive and be involved in the commercialisation of their ideas, rewards must be both sufficiently likely and sufficiently lucrative. However, academic career progression is linked to citation/publication rates and grants success. Researchers face an opportunity cost if they spend more time on

[66] This includes spin-off companies formed by universities, medical research institutes and major publicly funded research agencies. From 2004–11, in Purchasing Power Parity terms, OECD, *Commercialising Public Research: New Trends and Strategies,* 2013.

entrepreneurial activities such as business consulting or developing spin-off companies based on their IP.[67]

Opportunity to encourage entrepreneurial culture

The Government should consider ways to recognise entrepreneurship and the translation of research into commercial outcomes.

There are also concerns about the disincentives created by the amount of bureaucracy at the university level associated with 'going commercial' in Australia. For example, it has been standard practice for many Australian universities to assert university ownership of IP created by staff members within the course of their duties, although revenue sharing arrangements in some universities (e.g., Monash University and University of Queensland) provide better financial incentives for researchers.

Opportunity to reform IP arrangements to assist collaboration

The Government can reform IP arrangements to encourage collaboration. This can include strengthening IP guidelines for universities considering the possibility of making grants conditional on appropriate management and dissemination of IP, and releasing an IP toolkit (which will provide guidance to simplify discussions relating to IP between researchers and industry).

University-based technology transfer organisations (TTOs) also help Australian researchers engage industry and commercialise their research.

[67] ARC, *Research in the National Interest: Commercialising University Research in Australia*, 2000.

4. A plan for improving commercial outcomes from research

While Australia performs well against one important factor for achieving research impact—international excellence—we must build better bridges between research and industry, ensure our research is well focussed, and support an entrepreneurial spirit in our business and research communities.

Interactions between research and industry are complicated. Industry uses research in a range of ways according to market conditions, regulatory arrangements, skills and a host of other factors that influence the decisions of individual firms. Similarly, our research institutions and individual researchers have a range of motivations influencing where they target their effort.

To improve the commercial outcomes from publicly funded research, the underlying incentives must shift. The settings that underpin incentives for research-industry collaboration, such as grant mechanisms, should be adjusted. We should also examine the regulatory settings that influence entrepreneurship.

There is also value in better articulating Australia's research priorities. We cannot research everything and should focus research in the national interest. The best minds from across research, industry and government should formulate a set of high level priorities and corresponding important research challenges for Australia. These challenges should be practical problems that capture the imagination of our research and business communities.

Long-term change will be best achieved by system-wide adjustment. Articulating priorities and adjusting system settings, such as grant funding formulae, should generate a lasting shift in research focus and collaboration, while maintaining and enhancing Australia's reputation for research excellence.

5. Conclusions

The Government is developing a strategy to address these issues and increase the translation of research into commercial outcomes. This strategy will support the Government's commitment to boost Australia's economy, ensuring our competitiveness into the future. It will be aligned with the Government's measures to reform the higher education sector, realise the potential of health research and help businesses to grow, become self-reliant and thrive.

As a part of this strategy, the Government:

- has established the Commonwealth Science Council, chaired by the Prime Minister, to provide advice on important science and technology issues facing Australia that draws on industry, science and government experience.
- will consult with stakeholders to set national priorities for research. These priorities will align areas of national research excellence with Australia's industrial strengths, global trends and community interests. Each priority will be supported by practical research challenges that will be developed in consultation with experts from industry, research organisations and government.
- will assess existing research activity against the research priorities and practical challenges to ensure there is critical mass around each of the challenges. Where there are gaps, tailored strategies will be developed to address the specific challenge.

The Government will also pursue changes in a number of other areas to increase the commercial returns from research and invites comments on the proposals below.

Creating stronger incentives for research-industry collaboration

The Government will identify opportunities to adjust funding mechanisms to provide greater incentives for collaboration between researchers and industry. To achieve this outcome the Government is seeking input from the research and end-user community on opportunities to:

- modify rules for competitive research grants to appropriately recognise industry-relevant experience;
- develop research block grant arrangements that retain a focus on quality and excellence while supporting greater industry and end-user engagement;

- leverage greater collaboration between publicly funded research agencies and industry;
- consolidate existing programmes that focus on collaboration with industry to increase their scale and effectiveness; and
- consider whether the R&D Tax Incentive sufficiently encourages collaboration between industry and researchers.

Supporting research infrastructure

The Government will take steps to ensure that research infrastructure facilitates increased collaboration between researchers and industry. To achieve this outcome the Government is seeking to:

- strengthen the existing focus of the NCRIS on outreach to researchers and industry;
- undertake a reassessment of existing research infrastructure provision and requirements, in line with the recommendations of the National Commission of Audit; and
- develop a roadmap for long-term research infrastructure investment, in consultation with the research sector and industry.

Providing better access to research

The Government will put in place arrangements to provide industry and other end-users with better access to research. To achieve this outcome the Government is seeking to:

- strengthen IP guidelines for researchers;
- examine the potential to link research funding to the dissemination of IP;
- establish an online point of access to commercially-relevant research for business; and
- develop a whole-of-government policy to open up access for business and the community to publicly funded research.

These proposals will be supported by the release of an IP toolkit which will provide guidance to simplify discussions relating to IP between researchers and industry.

Increasing industry relevant research training

The Government will take steps to ensure that the research workforce is equipped to work with industry and bring their ideas to market. To achieve this outcome the Government is looking to provide greater opportunities for

industry relevant research training, provision of industry and business relevant skills, and recognition of PhD candidates with existing industry experience. These issues will be a focus of a review of research training arrangements which will be informed by consultation with the research sector and industry.

Measurement of outcomes

The Government will work with the research sector and industry to improve assessment of the research system, including improved metrics on engagement and knowledge transfer with industry, as well as research outcomes and impact.

Capitalising on the Medical Research Future Fund

The Government will ensure that the new Medical Research Future Fund supports collaboration between researchers and industry and drives the uptake of Australian medical research.

The Government welcomes the input of the research sector and industry on the aforementioned policy and programme changes, the approach and mechanisms for implementation, and interdependencies where change in one area could affect another.

Submissions can be lodged online through www.education.gov.au/current-reviews-and-consultations.

The deadline for submissions is 28 November 2014.