



Australian Government

Department of Education and Training

Inquiry into Innovation and Creativity: Workforce for the New Economy

**Submission from the Department of Education and Training to the
Standing Committee on Employment, Education and Training**

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Terms of reference

The House of Representatives Standing Committee on Employment, Education and Training will inquire into and report on matters that ensure Australia's tertiary education system—including universities and public and private providers of vocational education and training—can meet the needs of a future labour force focused on innovation and creativity.

The inquiry will have particular regard to:

- 1. the extent to which students are graduating with the skills needed for the jobs of today and of the future;***
- 2. matters relating to laws and regulations that may act as a barrier to education providers being able to offer qualifications that meet the needs of the new economy and fastest growing sectors;***
- 3. factors that discourage closer partnerships between industry; in particular small and medium enterprises, the research sector and education providers; including but not limited to: intellectual property; technology transfer; doctoral training practices; and rapid commercialisation;***
- 4. opportunities for generating increased economic activity, including further investment and jobs, through greater synergies among publicly funded research agencies, universities and other Australian research institutions with businesses and industry; including but not limited to: co-location, cluster formation and development of precincts between universities and industry;***
- 5. relationships between tertiary education entrepreneurship programs and public, private, and not-for-profit incubators and accelerators; and***
- 6. other related matters that the Committee considers relevant.***

Summary of key points

- A well-functioning tertiary education system – providing vocational education and training (VET), higher education and research – that delivers the skills Australia needs, now and into the future, is a key contributor to a strong and prosperous economy.
- Based on Department of Employment projections, Australia’s tertiary sector is broadly producing appropriate skills to meet future labour market challenges.
- Economies which invest more heavily in research and development tend to have higher productivity gains.
- Australia is an innovative and productive economy that would benefit from greater collaboration between the industry and research sectors. The portfolio funds programs which specifically help foster greater collaboration, such as the National Collaborative Research Infrastructure Strategy (NCRIS), Research Block Grants and Australian Research Council (ARC) programs.
- These activities are contributing to the goals of the National Innovation and Science Agenda, which seeks to:
 - support research and research collaboration
 - incentivise innovation and entrepreneurship, and reward risk taking
 - promote science, maths and computing in schools, and
 - identify and remove regulatory impediments to entrepreneurship and innovation.

Introduction

Australia is the 12th largest economy in the world and 6th in terms of gross domestic product per capita.¹ It is a productive and innovative economy, which is characterised by strong economic growth, increasing human capital and labour productivity and relatively low rates of unemployment. Notwithstanding adjustments in the resources sector, the Australian economy has undergone, and continues to undergo, some significant structural changes.

Looking to the future, the Australian economy will require an innovative and creative workforce, supported by the right skills and knowledge to continue to prosper. The department has a central role in ensuring that the workforce continues to develop these skills and knowledge through setting national policy direction, supporting tertiary education and fostering research and innovation.

Current economic conditions

Australia has enjoyed strong and uninterrupted economic growth since the early 1990s. In recent years, Australia's growth has been fuelled by an unprecedented resource boom, driven by growing demand from emerging Asian economies. Despite the wane of the resources boom and weaker commodity prices, Australia's economy is forecast to grow by 2 per cent this financial year and around 2.75 per cent in 2017-18.²

The historical growth has been underpinned by increasing human capital and significant gains to labour productivity. A highly-skilled workforce creates greater opportunities for labour mobility and collaboration across sectors and the proportion of young adults who hold a university qualification has increased from 12.5 per cent in 1991 to 37 per cent now.³ This trend is also consistent for tertiary qualifications more broadly, which has seen the proportion of young adults with a non-school qualification rise from 56 per cent in 1991 to 72 per cent now.⁴

Internationally, Australia has a relatively high proportion of young adults with tertiary qualifications, similar to economies such as the United Kingdom and United States and higher than other innovative economies, such as Germany.⁵ Overall, our education system is world-class, as recognised by the *World Bank Knowledge Economy Index*, which ranked Australia second in the world in the education pillar.⁶

Labour productivity has also increased since the early 1990s. Australia's labour productivity has increased by more than 60 per cent over this period.⁷ The department aims, through its funding of education providers and administration of national education and training policy and programs, to equip the Australian workforce with the skills and knowledge it requires to adapt to the upcoming challenges in the labour market and economy more broadly. These challenges include the ongoing transition from a resource and manufacturing based economy to a knowledge and service based economy, increasingly complex globalisation and competition, the ageing workforce, the effects of automation on workplaces and the ongoing revolution in how technologies change the way we access and process information and interact with the world.

¹ The World Bank, *Data Bank*, 2015.

² Mid-Year Economic and Fiscal Outlook 2016-17.

³ Australian Bureau of Statistics, *Survey of Education and Work (SEW)* defines young adults as 25-34 year olds

⁴ Australian Bureau of Statistics, *Survey of Education and Work (SEW)* defines young adults as 25-34 year olds

⁵ OECD *Education at a Glance*, 2016

⁶ World Bank, *Knowledge Economy Index*, 2012

⁷ Australian Bureau of Statistics, *Estimates of Industry Multifactor Productivity (cat 5260.0)*, 2014-2015

As generally characterised by a productive and healthy economy, unemployment remains fairly stable at around five and a half per cent, which despite rising beyond its lowest rate in more than three decades with the onset of the Global Financial Crisis, is still around Australia’s long-term trend.⁸ The duration of workers’ unemployment was also more often shorter just before the onset of the Global Financial Crisis, than in the two and a half decades preceding it.⁹

The development of a mass pool of highly skilled workers through education and training drives gains in productivity, which in turn helps support economic growth. This positive impact on the economy creates jobs and reductions in unemployment. The challenge for the future of the economy is to ensure that the working population has the right mix of skills to continue to drive this virtuous cycle.

1. Skills for the current and future labour market

The Review of the Demand Driven Funding System noted that, ‘the flexibility of the demand driven system in meeting skills shortages is a significant improvement’ and ‘overall, the statistics on skills shortages, applications and enrolments shows that both student demand and university supply respond to labour market demand’.¹⁰

The evidence shows that in courses related to most skills shortage occupations there was an increase in demand.¹¹ The supply of health graduates is increasing more rapidly both in the recent past and in the projected future in response to favourable employment outcomes for these graduates. For example, nursing employment is projected to grow faster than overall graduate employment between 2015 and 2020. Applications for nursing courses have also increased strongly.

Conversely, growth in the supply of creative arts graduates has been slower than average, reflecting their poorer employment outcomes. Natural and physical sciences graduates also showed weaker employment outcomes in 2016, relative to the average graduates, despite showing a sharp increase in supply. These courses continue to see above average growth in applications.

In engineering, undergraduate applications and completions have been subdued, which appears to be a response to the waning of the mining boom and manufacturing sector. The projected growth in employment of engineers is lower than average. Applications and completions in information technology (IT) is on par with average applications and completions growth, which mirrors the employment outcomes for graduates and projected employment growth both near the national trend.

Table 1, below, outlines these observations in more detail. In particular, it shows graduates who are in full-time employment, four months after graduation as a proportion of all those available for employment. It also shows the percentage change in completions from 2012 to 2015 and the change in applications from 2015 to 2016. All of these are by main field of study of the graduates. Finally, the table also provides estimates of forecast growth in employment from 2015 to 2020, on an annualised basis, by sector of employment.

⁸ Australian Bureau of Statistics, *Labour Force* (cat. 6202.0)

⁹ Australian Bureau of Statistics, *Labour Force, Detailed, Monthly* (cat. 6291.0.55.001)

¹⁰ Kemp, D. and Norton, A. *Review of the Demand Driven System*, pp 22 and 24

¹¹ *Graduate Outcomes Survey, 2016*

Figure 1, demonstrates the changes in employment by occupation compared to the change in undergraduate applications for those fields of education. It also shows that, broadly speaking, graduate applications are responding to projected growth in the occupations.

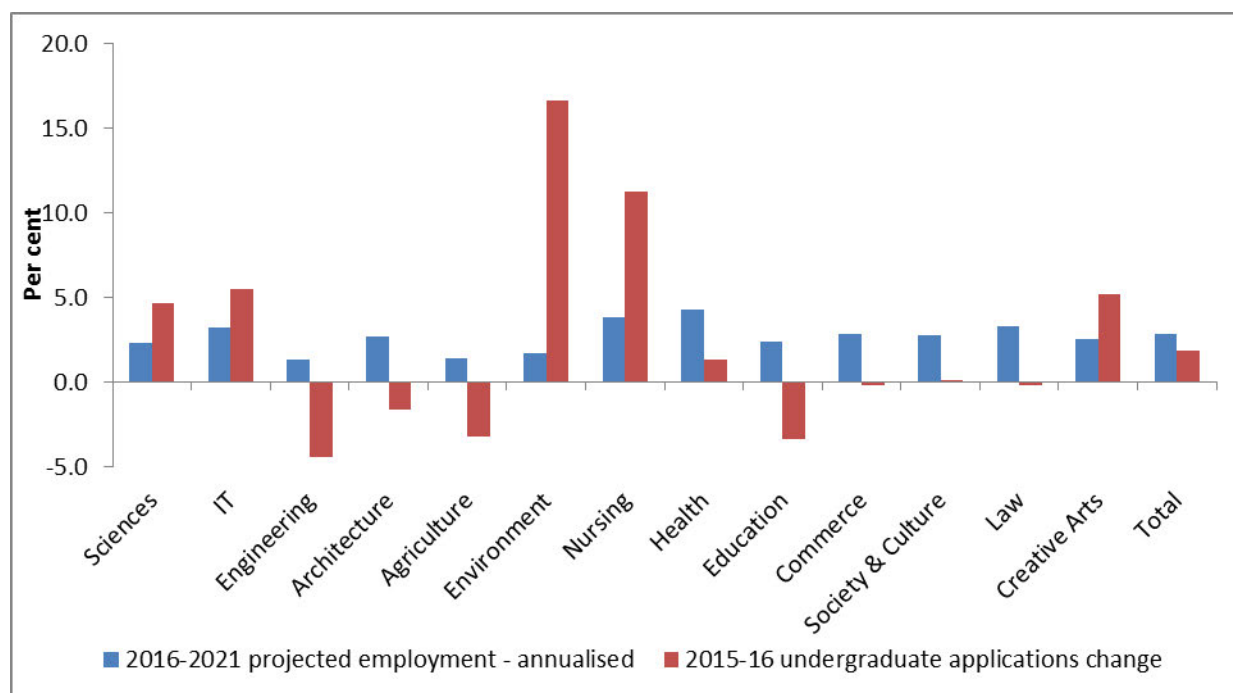
Table 1: Demand and supply for higher education graduates¹²

<i>Field of Education</i>	Current Demand and Supply for Graduates		Future Demand and Supply for Graduates	
	<i>2016 graduate employment (%)ⁱ</i>	<i>2012-15 undergraduate completions trend (%)ⁱⁱ</i>	<i>2015-2020 projected employment trend – annualised (%)ⁱⁱⁱ</i>	<i>2015-16 undergraduate applications change (%)^{iv}</i>
Natural and Physical Sciences	57.6	2.2	2.3	4.7
Information technology	71.6	1.7	3.2	5.4
Engineering and Related Technologies	76.4	-5.4	1.3	-4.5
Architecture and Building	75.3	5.5	2.7	-1.7
Agriculture and Forestry	78.8	-0.3	1.3	-3.3
Environment	53.4	-4.7	1.6	16.6
Nursing	82.3	0.8	3.8	11.2
Health Other	76.2	-0.9	4.3	1.3
Education	80.7	10.0	2.3	-3.4
Management & Commerce	75.4	2.5	2.8	-0.2
Society & Culture (excluding law)	61.0	-1.4	2.7	0.1
Law	72.0	-5.8	3.3	-0.2
Creative Arts	57.5	5.3	2.5	5.2
Total	70.9	-0.1	2.8	1.9

- i. Department of Education and Training, *Graduate Outcomes Survey*, 2016: percentage of graduates in full-time employment of those available for full-time employment, four months after completing their course.
- ii. Department of Education and Training, *Higher Education Student Statistics*, percentage change in undergraduate completions between 2012 and 2015
- iii. Employment projections by field of education prepared by the Department of Education and Training based on the Department of Employment occupational employment projections, percentage change in employment between 2015 and 2020
- iv. Department of Education and Training, Applications and Offers dataset, percentage change in undergraduate applications between 2015 and 2016 excluding applications to the Western Australia to tertiary admissions centre

¹² Department of Employment Skills Projections; Department of Education and Training analysis (unpublished); Department of Education and Training, *Higher Education Information Management System*, 2015

Figure 1: Changes in undergraduate applications relative to changes in projected employment growth¹³



Transparency

Providing transparency measures around the higher education admissions process such as clearer data on student experiences, outcomes and employment prospects will allow prospective students and their families to have the information they need to match their interests and ambitions with their abilities and needs for their future studies. This puts the onus on universities and higher education providers to be transparent about what they can offer prospective students.

The department provides a number of tools with relevant information and data to support the demand driven system for both the higher education and skills and training sectors. In higher education, the Quality Indicators for Learning and Teaching (QILT) website provides prospective students with relevant and transparent information about Australian universities and other higher education providers from the perspective of recent students and graduates. QILT student feedback contains data about student experience and graduate labour market outcomes; ensuring information is available for students to make informed decisions about their study options.

The department is also working closely with the Australian Taxation Office on a Higher Education Loan Program (HELP) data improvement project. An interim database should be in place by mid-2017 with the final database anticipated for early 2018. Once operational, the improved HELP database will provide richer data on the employment and income profiles of graduates.

In 2016, the Higher Education Standard Panel undertook an extensive Inquiry into higher education admissions practices. Access to and take-up of places in higher education has expanded significantly in recent years, in response to the introduction of demand-driven funding for bachelor degrees at public universities. The diversity of students seeking to enter higher education is increasing; as is the

¹³ Department of Employment Skills Projections; Department of Education and Training analysis (unpublished); Department of Education and Training, *Higher Education Information Management System*, 2015

range of their academic, social and economic backgrounds. To cope with this, institutions have developed a growing number admission pathways and assessment criteria to determine the capacity of applicants to undertake and succeed in higher education. Many of these alternative entry pathways are intended to assist students who have aptitude and capacity but may not have performed as well at school due to barriers including disability, economic disadvantage or social exclusion. The Panel's inquiry came in response to concerns that this greater variety and complexity of admission options was leading to confusion for prospective students and a lack of clear information to help them and their families make informed choices about the best higher education course, education providers and to suit their interests and abilities and their career objectives.

The Government has accepted all of the Panel's recommendations. A sector-led implementation working group is being established to develop a joint implementation plan with government, state tertiary admission centres and the independent higher education regulator, the Tertiary Education Quality and Standards Agency (TEQSA).

Implementation will include the establishment of a new national admissions information platform to help students and their families make more informed choices. The new information platform will provide a one-stop-shop entry point for information about higher education courses and providers, making it easier for prospective students to find and compare courses, including application and assessment requirements and information like graduate employment outcomes and the likely student cohort characteristics. Empowering choice to help students match their study to their goals and abilities is a key strategy to maximise the return on the significant investment of both money and effort – by students, their families and by taxpayers – to support and undertake higher education.

Implementation of the Panel's recommendations will also simplify cross-border applications, therefore making courses relevant to specific career paths more readily available to students from across Australia regardless of their state of origin.

In a follow-up to the work on admissions transparency, in 2017 the Panel will examine factors that contribute to student completions and attrition and completions and consider how best practice in supporting students through to successful course completion can be strongly embedded in provider practise. Maximising the rate of completion of courses and qualifications is important to ensure the greatest portability of skills and learning as graduates move through their careers.

Job ready

There are collaborative initiatives underway among university and industry groups to help make graduates more job ready. In 2015, Universities Australia, the Australian Chamber of Commerce and Industry, the Australian Industry Group, the Business Council of Australia and the Australian Collaborative Education Networked collaborated to develop Australia's first ever National Work Integrated Learning Strategy. The strategy provides industry with a practical role in giving students the skills and 'hands on' experience needed to meet employer expectations and quickly and effectively transition from education to employment.

The department, in its capacity as the agency responsible for administering the Australian Apprenticeships Incentives Program, also provides input into the National Skills Needs List (NSNL), which identifies traditional trades that are considered to be experiencing a national skills shortage.

Eligible employers of Australian Apprentices undertaking a qualification that leads to an occupation listed on the NSNL receive commencement and completion payments of \$4000, and may be eligible for a range of other special payments. The NSNL identifies traditional trade occupations (Australian and New Zealand Standard Classification of Occupations major group three) that are identified as experiencing a national skills shortage and is based on a range of criteria including analysis of skill shortages undertaken by the Department of Employment.

The VET system, like higher education, is an integral part of the Australian education system. Delivering training to almost 4.5 million students annually, it helps improve Australia’s economic prosperity by equipping students with workplace specific skills, designed by industry, for a wide range of occupations. It also represents an important economic and social opportunity for those seeking new employment opportunities, or those seeking to retrain. Industry involvement is a key factor for effective training and delivery.

Analysis of the employment outcomes for VET students provides insight into how various fields of study are faring in the labour market. Disciplines such as engineering and education and architecture seem to have particularly strong outcomes after training. Table 2, below, summarises these results. Specifically, it shows that VET students experience greater outcomes in the labour market post-training. Across all fields measured, VET students experience improved employment outcomes.

Table 2: Employment and further study outcomes after training (as at 29 May 2015)¹⁴

<i>Field of Education</i>	<i>With improved employment status after training (%)</i>	<i>Of those not employed before training, those who were employed after training (%)</i>	<i>Employed after training (%)</i>	<i>Of those employed before training, those who were employed at a higher skill level after training (%)</i>
Natural and Physical Sciences	42.6	28.0	67.5	16.5
Information technology	35.4	25.5	49.3	22.0
Engineering and Related Technologies	67.5	51.9	83.2	20.3
Architecture and Building	77.2	65.4	86.1	20.4
Agriculture environmental and related studies	65.0	28.7	80.9	10.1
Health	60.5	39.3	78.9	24.4
Education	63.5	52.4	86.2	6.8
Management & Commerce	54.0	38.5	73.2	14.0
Society & Culture	62.4	48.8	74.2	16.0
Creative Arts	39.3	28.3	56.4	16.9
Food, hospitality and personal services	60.7	44.3	75.1	17.4
Mixed field programs	30.5	21.5	40.3	8.4

¹⁴ National Centre for Vocational Education Research, *Student Outcomes Survey 2015*, December 2015, Table 25: Key findings for government-funded graduates by field of education

VET student loans

To support the VET system, the Commonwealth provides income contingent loans to eligible students studying higher level VET qualifications. The VET Student Loans program commenced on 1 January 2017 and replaces the VET FEE-HELP scheme which effectively ceased on 31 December 2016.

The VET Student Loans program will ensure the new program is student centred, delivers high quality training and is fiscally sustainable. The key features of the program are:

- Course eligibility that aligns with industry needs and employment outcomes to ensure access to loans is targeted to growth areas, with a particular focus on STEM courses
- An outcomes focussed application process for providers to access the scheme to ensure only high quality providers with a strong track record and good links to industry and approved to offer the scheme.

The VET sector also plays an important role in developing science, technology, engineering and mathematics (STEM) skills within the workforce. The Australian Bureau of Statistics has indicated that about half the Australian population with STEM qualifications have a Certificate III or IV as their highest level of qualification¹⁵. In addition, in 2015, over 900,000 VET students were undertaking training in STEM-related fields of study¹⁶. Many apprentices also gain much-needed trade-related STEM competencies through VET.

The new model for engaging Australian industry in the development of training products will play an important role in ensuring the VET sector continues to provide STEM capacity to the labour market. Strengthened industry leadership of training package development, so that training better aligns with jobs in the modern economy, will assist in delivering the skills that employers need to thrive in the competitive global environment.

Industry engagement

To ensure the VET system meets the needs of a future labour force, the Australian Government has introduced, as part of the current national VET reform agenda, a new model for engaging Australian industry in the development of training products that guide VET delivery. The new model aims to:

- strengthen industry leadership of training package development so that training better aligns with jobs in the modern economy
- prioritise the development and review of training packages based on industry demand for skills across sectors
- achieve collaboration across stakeholders involved in training package development

Recent reforms to training packages and the way they are developed will ensure the needs of industry are met now and into the future. The changes are designed to maximise industry involvement and ensure training produces the skills required by employers.

¹⁵ Australian Bureau of Statistics *Perspectives on Education and Training: Australians with qualifications in science, technology, engineering and mathematics (STEM), 2010-11*, (cat. 4250.0.55.005), 2014

¹⁶ National Centre for Vocational Education Research, *Australian vocational education and training statistics: total VET students and courses 2014* (unpublished), 2015

The Australian Industry and Skills Committee (AISC) was established – by jurisdictional and Commonwealth ministers with responsibility for education, skills and training – to provide industry with a formal role in providing industry advice to governments and approving VET training packages for implementation. The role is broad, and includes providing industry leadership in ensuring that the competencies, skill sets and qualifications identified in training packages evolve and adapt with the changing nature of jobs. The Committee is also charged with providing advice to ensure that the directions taken by Ministers are informed by an industry-based perspective, which is focused on the quality and relevance of training in VET.

Central to these arrangements are the Industry Reference Committees (IRCs). IRCs are the formal point through which industry requirements for skills are considered and defined in training packages, and they provide a conduit for industry feedback to government on industry trends and for promotion of VET to employers. IRCs are comprised of industry representatives with expertise from a cross-section of the particular industry or sector they serve.

Ensuring that training package development work is focused on meeting the needs of industry is paramount in the AISC's decision making. The first National Schedule (published in June 2016) of work commissioned by the AISC was informed by advice from IRCs and includes work aimed at:

- capitalising on advancements in technology
- keeping pace with new ways of working
- reflecting new jobs in the economy and
- addressing new security risks and threats and workplace health and safety issues.

The AISC takes a strategic look across all IRCs and commissions cross-sector projects that support individuals moving easily between occupations and skillsets that more quickly enable workers to re-skill or up-skill. The AISC also fast-tracks training package development where there is an urgent need and a clear case for change.

2. Legislative or regulatory impediments

The department provides overarching national policy direction and funding to the higher education and skills and training sectors. As part of this role, the department administers grants and programmatic funding to support students and researchers.

Universities are subject to a range of regulation including standards they must meet in the design and delivery of courses and qualifications. These include the Higher Education Standards Framework overseen by the Tertiary Education Quality and Standards Agency (TEQSA); Commonwealth and state legislation, financial requirements and individual acts of Parliament under which universities themselves are established. While not intended to impede in any way their ability to be flexible and adaptable in their approach to offering the right qualifications to meet the future needs of the labour market, such legislative and standards frameworks inevitably impose lead-times for design and accreditation of course units and qualifications. Australian universities all have self-accrediting status so are in a strong position to actively manage these processes in order to respond to emerging needs and innovations without needing sign-off of individual courses from TEQSA. However, formal academic governance processes do require an investment of time and resources to ensure the quality of their educational offerings.

Regulatory settings can play a key part in shifting incentives and help to influence entrepreneurship. For example, in December 2015, the Prime Minister announced the National Innovation and Science Agenda (NISA), which is delivering a range of new initiatives to support research, incentivise innovation and entrepreneurship, reward risk taking and promote science, maths and computing in schools. NISA also aims to remove regulatory obstacles to firms attracting the best workers through employee share ownership and access to crowd sourced equity funding.¹⁷

The NISA seeks to establish appropriate incentives to ensure the regulatory environment is conducive to innovation and collaboration. Specifically, two of the six NISA initiatives for which the department is responsible aim to simplify and streamline regulatory and administrative processes. The Sharper Incentives for Engagement measure is streamlining research block grants which support the indirect costs of research and research training in universities. The new arrangements reduce the number of schemes from six to two, reduce the number of indicators used to determine allocations and provide more discretion to universities about the level of support they can provide for students undertaking research training.

Changes to the ARC Linkage Project scheme involve the move from an annual to a continuous application process and fast tracking of decision-making. These arrangements will address the time-lag disincentives for industry and business partners to collaborate with universities under the scheme.

Intellectual property (IP) arrangements for higher education research is another area where the regulatory arrangements may act to impede efficient allocation of resources into research and development activities. IP arrangements are discussed in more detail under the next section.

¹⁷ Australian Government, *National Innovation and Science Agenda*, 2015

3. Closer partnerships between industry and research

It is difficult to assess the effectiveness of collaboration between researchers and businesses as there is a lack of reliable data. OECD data suggests that Australia has relatively low levels of collaboration between researchers and businesses. As illustrated by the OECD, Australia ranks last out of 26 countries¹⁸ for its level of collaboration between businesses and higher education and public research institutions on innovation. Similarly, Australia ranks only 23rd out of 32 countries on the proportion of research which is co-authored by researchers and industry sector.¹⁹

To address these gaps, the department is working with the Australian Research Council to develop a framework for a national assessment of engagement and impact of university research. This work is also aimed at encouraging universities to focus on improving their engagement with industry and other sectors which can benefit from research and to increase the translation of research into wider economic, social and other benefits. A pilot will be run in 2017 and will provide the basis for a national roll-out in 2018.

Ineffective research and 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.²⁰

The changing nature of work and occupational composition in industry sectors poses ongoing challenges, especially in the face of changing technology, structural changes in the economy, consumer trends and demographic changes in the Australian labour market. An adaptable and flexible workforce and innovative ways of conducting business are essential factors in meeting these challenges, both now and in the future.

While there are some good examples of collaboration, on balance the evidence suggests that both Australian industry and the research sectors could do better. On the business side, there are low levels of industry collaboration with the research sector by firms of all sizes, relative to other developed economies.²¹ 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.²² Similarly, only 9.7 per cent of innovative businesses had collaborative arrangements with universities and higher education institutions.²³

Strengthening links is critical. The OECD Innovation Strategy highlights the importance of small and medium-sized enterprises (SME) in translating knowledge and ideas into jobs and wealth.²⁴ Australia's industry structure is characterised by a large number of small businesses (over 97 per

¹⁸ Office of the Chief Economist, *Australian Innovation System Report*, 2015

¹⁹ OECD, *Commercialising Public Research: New Trends and Strategies*, 2013

²⁰ Department of Education and Department of Industry, *Boosting commercial returns from research*, 2014

²¹ OECD, *Science, Technology and Industry Scoreboard*, 2013

²² Australian Bureau of Statistics, *Innovation in Australian Business*, (cat. 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 29.6% of Australian businesses reported sourcing ideas from 'websites, journals, research papers or publications'.

²³ Australian Bureau of Statistics, *Innovation in Australian Business*, (cat. 8158.0), 2012-2013

²⁴ OECD, 2010, *The OECD Innovation Strategy: Getting a Head Start on Tomorrow*.

cent of active businesses in Australia have fewer than 20 employees).²⁵ Small business expenditure on R&D represents only 19 per cent of total business expenditure on R&D.²⁶

International examples of innovation districts and precincts also highlight the benefits of greater industry and research partnerships. The Cambridge Science Park in the UK is a business cluster with sectors in electronics, computing, software, scientific instruments and pharmaceuticals leveraging scientific research provided by Cambridge University.²⁷ It produced 1400 start-up firms employing more than 53,000 people and a combined revenue greater than 13 billion pounds per annum.²⁸

A 2014 report by the Brookings Institution Metropolitan Policy Program in the United States (US) also highlights the importance of greater industry and research collaboration through “innovation districts” which have evolved as part of a “new geography of innovation”.²⁹ These innovation districts in the US aim to develop productive and sustainable economic growth and address significant challenges facing American society today including: “sluggish growth, national austerity and local fiscal challenges, rising social inequality, and extensive sprawl and continued environmental degradation.”³⁰

In line with these trends, a number of Australian universities have established or are exploring similar arrangements involving local partnerships with industry. Greater engagement and collaboration between university researchers and industry through such arrangements has been an area of increasing focus recently. The department supports a number of initiatives which are contributing to increased university-industry collaboration.

National Collaborative Research Infrastructure Strategy (NCRIS)

The Australian Government through NCRIS invests in key areas of national infrastructure which underpin high quality research which support national priorities. This investment facilitates the engagement of researchers with industry and other end-users, as well as providing industry users with access to research infrastructure which supports private sector research and development. To ensure that industry collaboration is maximised, the development and implementation of industry engagement plans has been introduced as a condition of funding for all NCRIS projects. A review of the 2016 plans, show that NCRIS projects are actively involved in facilitating industry-research engagement, as well as engaging directly with businesses, contributing to boosting commercial returns from research. There does, however, remain an ongoing drive to improve industry use of and benefit from research infrastructure.

As part of the National Innovation and Science Agenda, the Australian Government commissioned the development of a National Research Infrastructure Roadmap. The department is leading a whole of government taskforce to support an expert working group in developing the Roadmap, which will suggest a framework for investment decisions over the next decade. The draft 2016 Roadmap was released in late 2016 for consultation and the final will be provided to the government in early 2017.

²⁵ Australian Bureau of Statistics, 8165.0 - *Counts of Australian Businesses, including Entries and Exits, Jun 2010 to Jun 2014*.

²⁶ Australian Bureau of Statistics, *Experimental Estimates of Business Research and Development* (cat 8104.0)

²⁷ <http://www.cambridgesciencepark.co.uk/>

²⁸ <https://www.awri.com.au/wp-content/uploads/2013/09/dean-w38-awitc15.pdf>

²⁹ Brookings Institution, *The rise of innovation districts: A new geography of innovation in America*, 2014. p. 6

³⁰ Brookings Institution, *The rise of innovation districts: A new geography of innovation in America*, 2014. p. 2

Funding for higher education research and research training

The Australian Government also provides funding for university research and research training through a mix of specific project and block grant funding. The ARC administers the National Competitive Grants Program (NCGP), which supports both basic (or fundamental) research and applied research. The NCGP comprises two programs—Discovery and Linkage—which seek to maintain a balance between supporting research to build fundamental knowledge needed to underpin real world application and directly applied research to benefit the community, environment and industries.

While the NCGP provides the direct costs associated with undertaking a specific research project, universities also receive funding through the department for research block grants which support the systemic cost of research and research training. Introduced under the NISA, the Sharper Incentives for Engagement measure introduces new incentives to drive greater research-industry collaboration. An additional \$50 million per annum (indexed) will increase the allocation available to those universities which gain additional research income from industry. This stronger incentive is expected to drive universities to boost engagement with end users to develop deeper and more effective research relationships over time. The measure will continue to support research quality, ensuring a balance between financial rewards for success in competitive grants and engagement with end users.

Starting 1 January 2017, the previous six research block grant schemes have been streamlined to form two new schemes:

- the Research Support Program (RSP) to support the systemic costs of university research.
- the Research Training Program (RTP) to support the training of research students.

Arrangements through the RTP will allow universities more flexibility in the level and type of support they provide for research training students, including enhanced opportunities to gain exposure to industry experience. Over time, this will drive cultural change as better prepared graduates take their place in the innovation system and begin to influence its direction.

As mentioned above, under the NISA, the Australian Government has streamlined and accelerated access to research project funding focussed on industry and other end user collaboration. The Australian Research Council's Linkage Projects scheme has opened continuous applications for funding. These Linkage Projects bring together researchers, business, industry and other end-users to solve problems that help generate more products and services for Australia's economic, commercial and social benefit.

To ensure that the research training system is of the highest quality and capable of meeting future workforce needs, the former Minister for Education and Training, the Hon. Christopher Pyne, MP commissioned the Australian Council of Learned Academies (ACOLA) to review Australia's research training system. The review, delivered in 2016, concluded that the system performs well in terms of training our future academic researchers but highlighted areas for improvement:

- providing flexible regulatory and funding arrangements for Higher Degree by Research (HDR) training
- improving industry training opportunities and collaboration
- ensuring funding arrangements better support Indigenous HDR student participation.

The Government has accepted all the recommendations of the Review. A number of recommendations have already been addressed. The Government's changes to research block grants will incentivise industry-university engagement and offer universities autonomy and flexibility in allocating research funding and research training funding. The Government will provide funding of \$28.2 million over the next four years to expand the PhD industry internships program run by the Australian Mathematical Sciences Institute (AMSI) to a national scale program with a particular focus on increasing the number of science, technology, engineering and mathematics (STEM) and female research students participating in the program. Expanding options for research students to gain high quality industry experience through internships and other work integrated learning initiatives is an important means of driving cultural change in both the industry and the university sectors. Providing industry experience during the early stages of research careers and increasing business awareness of Australia's research talent are essential to improving collaboration and mirror long-established practices in more innovative economies. As recommended by ACOLA, the Government has also supported the establishment of a working group, involving the university sector, industry, government and community stakeholders, to consider further actions to respond to the review's findings and develop an implementation plan during 2017.

Intellectual property and open access

The Government already supports open access to publicly funded research publications. Free and open access to research outputs facilitates knowledge transfer and commercialisation, and there is growing consensus domestically and internationally that it should be supported, as far as possible, subject to practical constraints (for example privacy issues and IP agreements with private sector partners). The ARC and National Health and Medical Research Council (NHMRC) already require publications arising from government funded grants to be made available in a publicly accessible repository within twelve months of publication. Further work is being undertaken in collaboration with relevant government agencies and Universities Australia to develop a national approach to opening access to research publications and data, including development of high-level principles for opening access to the data and publications arising from publicly funded research.

The Department is also working with relevant agencies to develop a response to the recommendations regarding providing access to publically funded research in the Productivity Commission (PC) Inquiry into IP arrangements released publicly on 20 December 2016.

4 & 5. Opportunities for generating increased economic activities and relationships with tertiary education entrepreneurship and other sectors

Research and development is a significant driver of innovation which leads to productivity and economic growth. It is no coincidence that countries which invest more heavily in research and development tend to have higher productivity. Figure 2 and 3, below, shows the relationship between expenditure on research and development and the growth in multifactor productivity (MFP), averaged over the 8-year period 2000 to 2008 (pre-GFC) and the 6-year period from 2008 to 2014 (post-GFC). It demonstrates that there is a positive correlation between R&D expenditure and productivity growth. The data were analysed in this way to recognise the vastly different patterns of investment between the pre and post-GFC periods.

Figure 2: R&D expenditure (share of GDP) and MFP growth rate (8-year average 2000-08)³¹

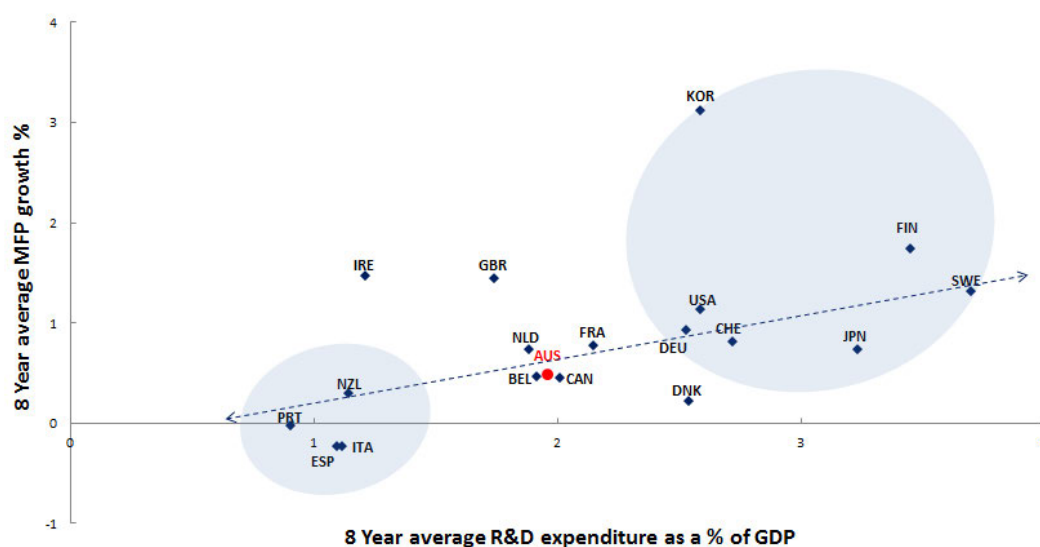
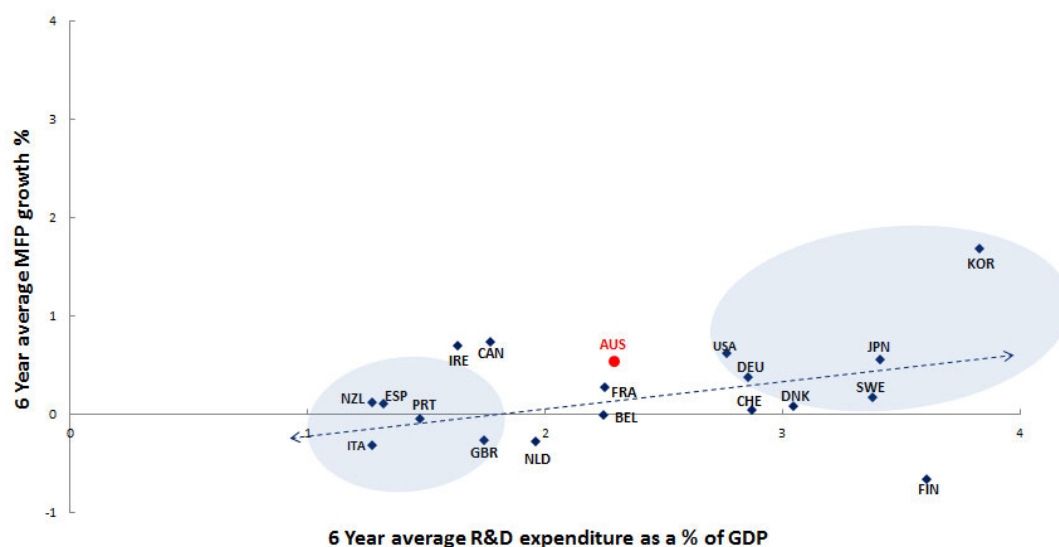


Figure 3: R&D expenditure (share of GDP) and MFP growth rate (6-year average 2008-14)



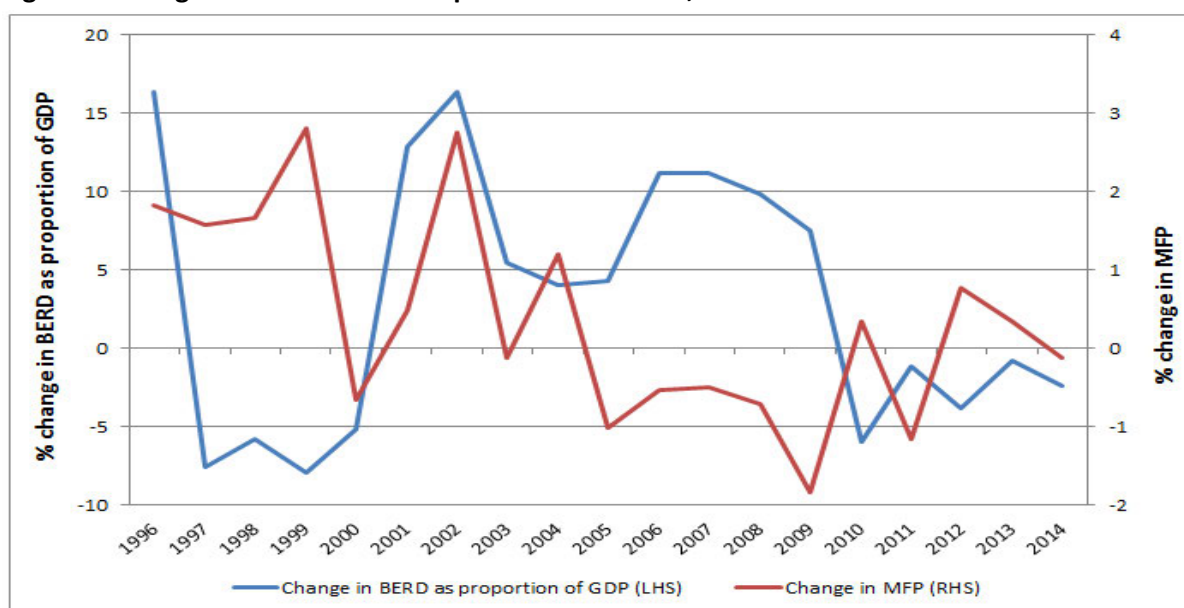
As noted above, there is a positive link between productivity and GDP growth in both the pre and post-GFC periods. Further empirical evidence suggests that from the period 1993-2012, a sustained

³¹ World Development Indicators 2016, Internal analysis

one per cent increase in research and development expenditure on higher education and publicly funded research organisations would have increased Australia’s multi-factor productivity by nearly half a per cent.³² Conservatively, this means that a one per cent increase in public research and development expenditure is estimated to increase Australia’s future GDP by around \$6.7 billion.³³

On the business side, investment in business research and development is also associated with gains in multifactor productivity – which is not surprising, given more than half of gross expenditure on research and development is in the business sector. Industry offers the opportunity to commercialise and diffuse research through the economy, provided that the incentives and regulatory landscape are conducive. At any rate, over the past two decades, changes in business expenditure on research and development have been closely followed by changes in multifactor productivity. This is demonstrated by Figure 4, below.

Figure 4: Changes in business R&D expenditure and MFP, 1996-2014³⁴



Government also plays a role in business research and development. Based on international data, there appears to be a positive correlative relationship between changes in direct Government expenditure on business research and the level of venture capital available to businesses. There could be many reasons why this relationship exists. For instance, it could be that economies where the Government has a larger role in investing in innovative business ventures, industry responds positively to the signal in the market and is more likely to also invest in innovative start-ups and experimental projects. Recent data suggests that while Australia has a relatively low proportion of its business expenditure on research and development directly supported by Government investment – around 1.9 per cent³⁵ – it yields a relatively strong return in terms of venture capital. Figure 5, below, shows this correlation using data from OECD countries.

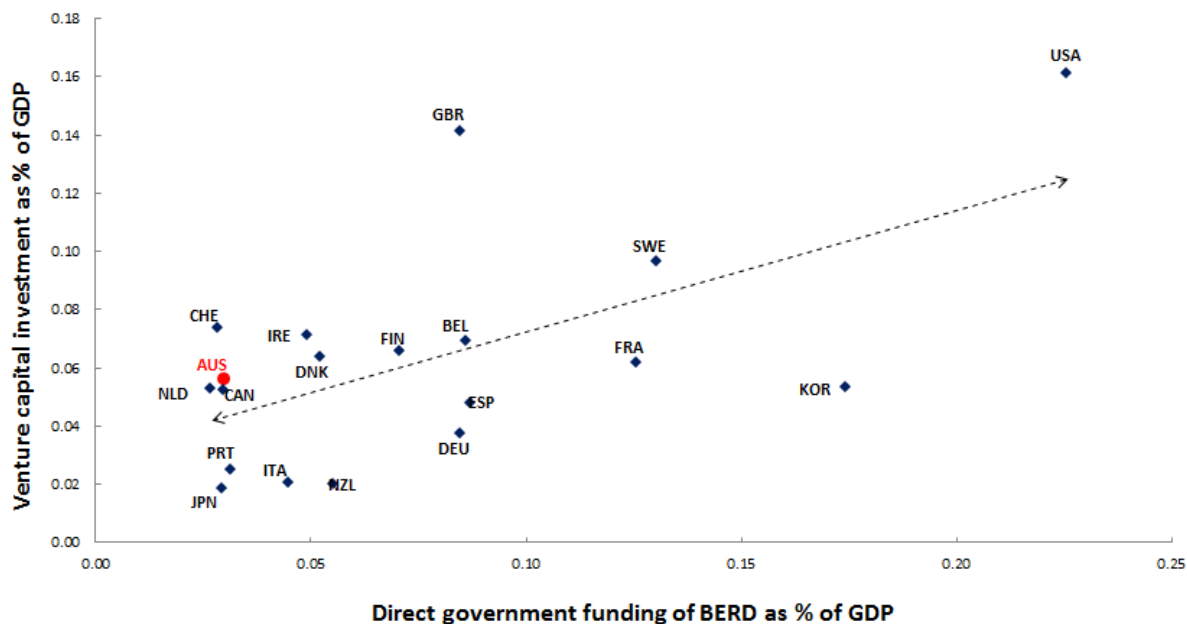
³² Fox and Elnasri, *The Contribution of Research and Innovation to Productivity and Economic Growth*, 2014

³³ Fox and Elnasri, *The Contribution of Research and Innovation to Productivity and Economic Growth*, 2014; Australian Bureau of Statistics, *Multifactor Productivity* (cat 5260.0), 2013-14

³⁴ Australian Bureau of Statistics, *Multifactor Productivity* (cat 5260.0) and R&D (BERD) (cat 8104.0)

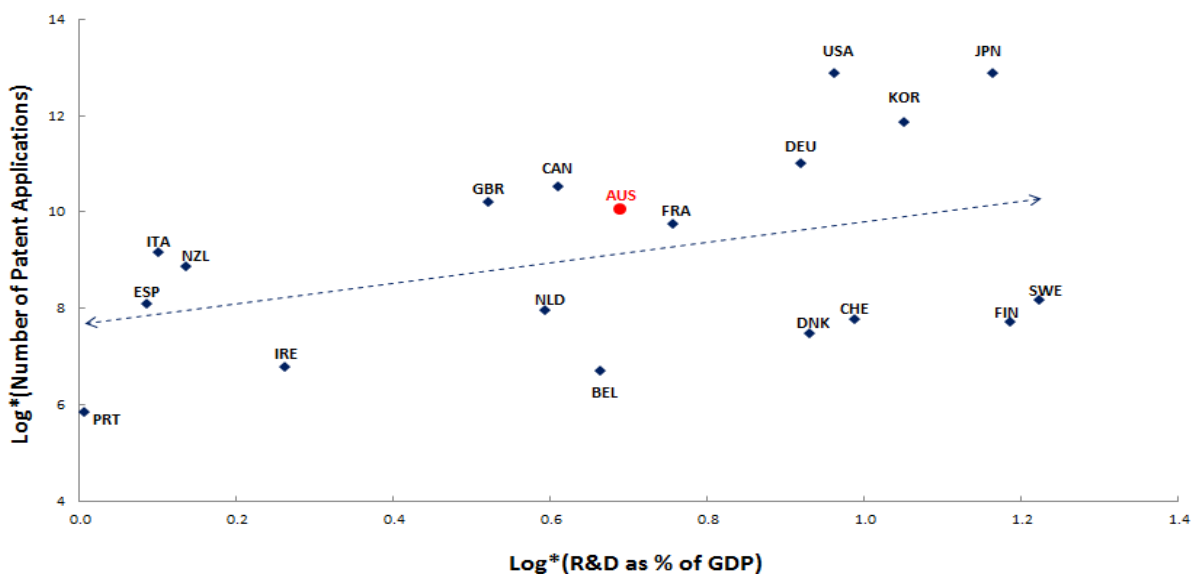
³⁵ Experimental Estimates of R&D – 8104.0

Figure 5: Level of venture capital as a function of direct Government spending on private R&D, 2006-2014³⁶



Greater investment in research and development should be expected to lead to greater commercial outcomes. Similar to improving productivity, countries that invest more heavily in research and development are more likely to have greater numbers of patent applications, which would ideally lead to commercial outcomes. Figure 6, below, shows the relationship between marginal changes in the proportion of GDP devoted to research and development and changes to the number of patent applications, over time. It shows that changes in the level of an economy’s expenditure on research and development is proportionally reflected in the number of patent applications lodged by industry and research sectors.

Figure 6: Sensitivity of change in patent applications to changes in R&D expenditure, 1996-2014³⁷



³⁶ OECD Science, Technology and Industry Outlook 2014, internal analysis

³⁷ World Intellectual Property Organization and *World Development Indicators 2015*, internal analysis

Irrespective of the source of the funding, support for all research and development activities is essential to continue to foster productivity growth. In turn productivity growth drives economic and jobs growth. For example, as productivity increases, employers are able to produce more for the same inputs. They are able to expand production and hire more workers. Increased production in one sector drives greater demand for intermediate and complementary goods and services and accordingly drives growth in complementary sectors. While the exact extent of the relationship is not immediately obvious, one thing is clear; support for research and development activities in higher education, research agencies, governments and business is a good investment.

The Government is committed to supporting higher education and public sector research agencies to foster strong relationships in industry, including harnessing collaborative approaches through initiatives such as industry precincts clustered with or located on campuses, incubators and accelerators. To this end, the Government provides funding and support to ensure that research and industry sectors have greater access to one another and are able to better collaborate on the development, incubation, commercialisation and diffusion of innovative ideas and technologies arising from research.

Funding for national research infrastructure under NCRIS is a key component of this strategy. Between 2004-05 and 2016-17, the Government has invested \$2.8 billion to support a network which provides openly accessible research infrastructure. Access to infrastructure is provided to more than 35,000 Australian and international researchers each year. There are currently 27 projects which cut across the research and industry sectors, whose partners and collaborators include higher education providers, businesses, publicly funded research organisations, medical research institutes, Commonwealth, state, territory and local government departments and agencies. Australian Government funding of \$2.8 billion has leveraged co-investment of around \$1 billion from these partners. Under NISA, ongoing funding for NCRIS projects of \$150 million per annum (indexed) has been secured. The 2016 National Research Infrastructure Roadmap, currently being developed, will provide a framework to guide investment decisions over the next decade.

National research infrastructure funded under NCRIS has formed the basis of a number of university-industry precincts or clusters. For example, the Australian Manufacturing and Materials Precinct is home to 40 per cent of Victoria's manufacturing companies, as well as CSIRO, Monash University, the Australian Synchrotron, and the Melbourne Centre for Nanofabrication, which is a node of the NCRIS Australian National Fabrication Facility (ANFF). The ANFF supports industry by both providing companies access to its facility portfolio, and also complementing their R&D with expertise from the ANFF network of researchers.

The Deakin University Australian Future Fibres Innovation Facility (AFFRIC) at Waurin Ponds provides another example of the importance of NCRIS facilities in underpinning university-industry precincts. AFFRIC produces carbon fibre and has established partnerships with industry. It is also, through the relocation of CSIRO materials to the site, producing future fabrics (yarn) for commercial use.

Funding through the ARC Linkage Program for Industrial Transformation Research also contributes to the formation of clusters or research-industry "hubs". The Industrial Transformation Research Hubs is a scheme that will engage Australia's best researchers in issues facing the new industrial economies and training the future workforce. This scheme will support collaborative research activity between the Australian higher education sector and industry designed to focus on strategic outcomes not independently realisable. The program focusses on research in the Industrial Transformation Priorities. The priorities for Industrial Transformation Research Hubs for funding

commencing in 2017 and Industrial Transformation Training Centres for funding commencing in 2017 are:

- Advanced Manufacturing
- Food and Agribusiness
- Oil, Gas and Energy Resources
- Mining Equipment, Technology and Services
- Medical Technologies and Pharmaceuticals.³⁸

In 2015, five hubs received ARC funding under the program, totalling more than \$15 million over the life of the projects. For example, the ARC Research Hub for Integrated Device for End-user Analysis at Low-levels received funding of more than \$3 million over five years and aims to radically improve sensitivity, selectivity, speed and cost for detection of biological materials. Another, the ARC Research Hub for Graphene Enabled Industry Transformation received funding of more than \$2.5 million over five years and aims to provide the advanced materials industry requires with innovative solutions to tackle critical and complex challenges of national significance.

University and research precincts can stimulate higher levels of innovation, collaboration between business and research communities, and new business growth. The Government is also developing a National University Precincts Strategy, which will build on existing university precinct activity and better coordinate collaboration between industries, universities and governments. The Government has established a Precincts Advisory Committee representing industry and the university sector to provide strategic advice on the development of the strategy. The Committee will provide recommendations to the Government in late 2017.

Conclusions

Australia faces significant challenges going forward. Digital disruption, automation, structural changes in the economy and an ageing workforce will require Australia to continue to build its pool of highly skilled labour, with the right skills to adapt and innovate, as well as the right technology and infrastructure in place.

The department continues to work with the sectors to better facilitate collaboration, build infrastructure and foster the right skills in the economy to remain affluent and internationally competitive. NISA identified a number of areas where Australia can improve, including through better collaboration between research and industry sectors and developing the right skills for driving innovation in future generations. As outlined by NISA, innovation remains a priority for Government. Through the continued funding and support of innovation activities, Australia has the opportunity to embrace the challenges of the future with a highly-skilled workforce and resilient and adaptable economy.

³⁸ <http://www.arc.gov.au/industrial-transformation-research-program>