

Chapter 2

Key challenges to innovation in Australia

2.1 The Commonwealth Scientific and Industrial Research Organisation (CSIRO) detailed two features of a highly functioning innovation system. First, high levels of connectivity between businesses, government and research organisations to facilitate the stocks and flows of knowledge. Second, high levels of R&D talent within organisations that absorb new technologies and developments.¹

2.2 Australia has a history of research and technological advancement.² Australia's highly educated population and world-class research facilities were highlighted in evidence.³ However, a common contention raised throughout the inquiry was that, while Australia performs well in research, producing a wide range of intellectual property from basic discoveries to applied discoveries that are worth commercialising, such innovation is not developed into tangible wealth creation including employment.⁴

2.3 An instructive example of this argument was provided by the then Vice-Chancellor of Monash University, Professor Edward Byrne AC:

Australia has superb research universities for a country of our size and considerable additional investment in CSIRO. We have produced a lot intellectual property ranging from basic discoveries to applied discoveries that are worthy of commercialisation. It is widely recognised however that we fall short in this area with a failure to develop innovation in this country into tangible wealth creation including job creation. There is a common view to which I subscribe that Australia must develop an increased presence in niche and clever industries to sustain our economy at its current level of affluence in the decades ahead.⁵

1 CSIRO, *Submission 36*, p. 5.

2 For example, Engineers Australia referred to the following technologies developed through Australian research and development: the diagnostic ultrasound, Cochlear implants, breathing aids to treat sleep apnoea, construction cranes, tunnelling technology, Ausra large-scale solar thermal system, buried contact solar cell, foundations of WiFi technology, Jindalee over-the-horizon radar, Australia Telescope, Sydney Coordinated Adaptive Traffic System, black box flight recorder, Jira collaborative workplace software, variable rack and pinion steering, orbital engine, wave piercing catamarans and Scramjet. Engineers Australia, *Submission 46*, p. 4. Pfizer noted that in health matters, Australia has produced ten Nobel Laureates, 'one of the highest number per head of population of any country'. Pfizer Australia, *Submission 138*, p. 3.

3 For example, see Association of Australian Medical Research Institutes, *Submission 85*, p. 4.

4 Professor Edward Byrne AC, Monash University, *Submission 1*, p. 1. However, the CSIRO highlighted some collaborations—see *Submission 36*, p. 36.

5 Professor Edward Byrne AC, *Submission 1*, p. 1.

2.4 The ATSE also noted that Australia's poor ranking in measures of translating research into economic outcomes means that the profitability of our businesses are negatively affected.⁶ Similarly, CleanTech Pty Ltd submitted:

At the highest level and as well recognised, Australia produces some excellent research outcomes but struggles to bring these concepts to fruition in a way that provides economic advantages for the country. Through Australian CleanTech's international work, we frequently find surprise that Australia does not support commercialising its excellent research to a greater extent. The return on investment in research is therefore good when considering global reputation but poor when considering economic payback.⁷

2.5 The Department of Industry (Department) noted that 'radical innovation' in Australia is less common than incremental innovation, with a recent survey finding that 70 per cent of innovation investment is directed to incremental innovation, compared to 30 per cent directed towards radical innovation. The Department stated that other developed economies have a much higher proportion of radical innovation. The Department suggested:

A more balanced mix of innovation capabilities will enhance Australia's ability to compete in the global economy and better exploit emerging market opportunities. While the risks associated with radical innovation are generally much greater than those associated with incremental innovation, the rewards and benefits to businesses, the economy and broader society can also be far more significant. For example, evidence shows that firms at the leading edge of radical innovation tend to dominate world markets and to promote the international competitiveness of their home economies.⁸

2.6 While the commercialisation of research and innovation was emphasised in evidence to the committee, the view was put that pure research, which is looking three, five or ten years ahead, should not be integrated with commercial development and innovation.⁹ CSIRO also recognised the need for a balance:

A national innovation system that balances investigator-led research, mission-directed research, in-firm research, and that supports the translation of publically funded research outputs into the private sector, would help the Australian economy better shift to a focus on production of high value goods and services which is essential to managing the structural adjustment arising from the slowing of the mining sector and also differentiate ourselves in the quickly developing Asia-Pacific region.¹⁰

2.7 It is also important to note that, while the sciences are critical to all forms of innovation, not all science is the equivalent of innovation: the importance of

6 Australian Academy of Technological Sciences and Engineering, *Submission 96*, p. 2.

7 Australian CleanTech, *Submission 4*, pp 1–2.

8 Department of Industry, *Submission 110*, p. 5.

9 Mr Kevin Bloch, Cisco Systems, *Committee Hansard*, 24 August 2015, p. 7.

10 CSIRO, *Submission 36*, p. 21.

scholarship for its own sake – conducted independently of an underlying commercial motive – should not be overlooked. In particular, the committee wishes to highlight the importance of the Australian Government continuing to support excellence in all forms of research. This will require the maintenance of a rigorous system of peer-review, in order to ensure that Australia's high international standing in science and research is protected and strengthened.

2.8 While the significance of the sciences to innovation can hardly be overstated, especially in relation to the core STEM subjects (science, technology, engineering and mathematics), it would be equally unwise to overlook centrality of the arts, humanities and social sciences in a future-oriented innovation strategy. The jobs and industries of the future will depend on a workforce that can harness the wide-ranging skills that are fostered, collectively, by the sciences, the arts, mathematics and technology. The final section of this report will explore these connections in greater detail.

2.9 Another area of concern raised in evidence was that of access to risk capital. The Australian Institute for Bioengineering and Nanotechnology (AIBN) made the point that high risk capital was a core component of a vibrant innovation system.¹¹ Evidence to the committee suggested that government could play a substantive role in 'de-risking' industries and early stage ventures in order that it becomes more attractive to potential venture capitalists.¹²

2.10 Along with the lack of a risk appetite and openness to new ideas reflected in a shortage of risk capital for early stage commercialisation, the committee received evidence of a range of other barriers to innovation and a strong innovation system.¹³ The key themes that emerged during the inquiry included: the need for stability and certainty in relation to both funding and policy settings; coordination, cross-sector collaboration and a strategic approach to building innovation capability; nurturing start-ups and the need for an innovation culture; and an education system (including schools, vocational education and universities) focused on the development of skill sets and knowledge creation to ensure that Australians are fully equipped to engage productively in the future economy.¹⁴

2.11 These themes were encapsulated in the evidence of Professor Deborah Hodgson, Pro Vice-Chancellor, Research and Innovation at the University of Newcastle:

11 Australian Institute for Bioengineering and Nanotechnology, *Submission 61*, p. 2.

12 Ms Roslyn Mitchelson, Medical Technology Association of Australia, *Committee Hansard*, 24 August 2015, p. 11; Mr Justin Strharsky, Resource Innovation through Information Technology, *Committee Hansard*, 24 August 2015, p. 26; Mr Serg Duchini, Deloitte Touche Tohmatsu, *Committee Hansard*, 3 August 2015, p. 26.

13 Australian Institute for Bioengineering and Nanotechnology, *Submission 61*, p. 1; Chief Scientist, *Submission 20*, p. 3; Business Council of Australia, *Submission 175*, p. 12.

14 Ms Susi Tegen, Medical Technology Association of Australia, *Committee Hansard*, 24 August 2015, p. 10; Mr David Harrison, University of Western Australia, *Committee Hansard*, 24 August 2015, p. 12.

Innovation works. Its outputs add value and deliver economic growth and opportunities, but it does not happen by accident. It takes a vibrant and productive ecosystem, and particularly catalysts. A key catalyst is likely to be the support of all levels of government and incentives that will support entrepreneurial activity and investment in building critical mass in regional research assets, and the onward translation of research are both key policy drivers. These might include targeted tax breaks for companies setting up in regional Australia, removal of regulatory burdens for start-up businesses or incentivising angel inventors through the tax system.¹⁵

2.12 The remainder of the chapter considers these key themes in greater detail and provides recommendations directed at securing Australia's innovation future.

R&D funding and policy stability

2.13 In 2012, changes were announced to the Prime Minister's Science, Engineering and Innovation Council (PMSEIC). As part of the reforms directed at making it more 'relevant and responsive to the immediate challenges' of the nation, PMSEIC's terms of reference were modified to provide for a greater strategic approach to Australia's science, engineering and innovation.¹⁶ Then in October 2014, as part of the Industry Innovation and Competitiveness Agenda, PMSEIC was reformed and reinvigorated as the Commonwealth Science Council (CSC). The CSC was established to 'bring together the leaders of Australia's industry, research and government to advise on national priorities for science and research'.¹⁷

2.14 A key theme underpinning the inquiry was that innovation requires not only consistency in policy approach but also stability in governance arrangements for advisory bodies, including the CSC, which provide expert advice to inform policy making.

2.15 In its submission to the inquiry, GSK argued that, for the success of its operations in Australia, the most important factor is the maintenance of a stable and predictable policy environment.¹⁸ The ATSE argued that government programs can have a diminished effect due to 'inconsistency, constant changes, small scale, and lack

15 Professor Deborah Hodgson, University of Newcastle, *Committee Hansard*, 8 October 2014, p. 2.

16 Department of Industry, Innovation, Science, Research and Tertiary Education, Revitalised Prime Minister's Science Council, *Media Release*, 20 January 2012, <http://archive.industry.gov.au/ministerarchive2013/chrisevans/mediareleases/pages/REVITALISEDPRIMEMINISTERSSCIENCECOUNCIL.aspx.htm> (accessed 24 November 2015).

17 Australian Government, *Industry Innovation and Competitiveness Agenda*, October 2014, p. xix, http://www.dpmc.gov.au/sites/default/files/publications/industry_innovation_competitiveness_agenda.pdf (accessed 24 November 2015).

18 GSK, *Submission 103*, p. 1. See also Telstra, *Submission 171*, p. 4.

of effective evaluation'.¹⁹ Representatives of research institutions argued that government funding must be maintained 'and every effort made to increase it'.²⁰

2.16 The view was put by Professor Attila Brungs, Vice-Chancellor at the University of Technology Sydney (UTS), that Australia's innovation system 'lacks a coherence nationally and, importantly, a continuous approach around innovation'. He argued that it needs to be 'holistic, largely bipartisan and, importantly, not stop-start as programs and funding go but with long-term certainty of policy and programs'.²¹ These views were supported by many other submitters to the inquiry.

2.17 As part of shifting focus away from an emphasis on publications and to change culture, the Medical Technology Association of Australia argued in favour of key performance indicators in relation to research and development funding, which should be focused on working with industry and commercialisation.²²

2.18 Ms Susi Tegan, Chief Executive Officer (CEO) of the Medical Technology Association of Australia informed the committee that, while the research and development tax incentive was an important initiative, it usually takes up to 15 years for a company to go from an idea to commercialisation to making some money. As a consequence, there is a need for incentives by way of support and policy setting along the way.²³

2.19 Taking a more positive view of the Commonwealth's research and development tax incentive, CSL, a leading manufacturer of biopharmaceuticals, took the view that it remains, especially for smaller firms, a valuable aid to the development of new products, which frequently require a significant early commitment of capital.²⁴ Additionally, from the perspective of a national strategy for improving Australia's innovation capacity, CSL pointed out that private sector research and development, while it does not rival the university system, produces significant knowledge spill-over effects. Given the benefits that these spill over effects produce, both economically and culturally, CSL took the view that a strong case can be made for government support of private sector research and development activities.

2.20 Shifting away from public sources of funding incentives for Australian innovation industries, Mr Trent Bagnall, Co-founder of Slingshot Accelerator Pty Ltd,

19 The ATSE suggested that '[e]ven long-running, proven successful programs such as the Cooperative Research Centres have been subject to decreasing levels of support and uncertainty for applicants and participants'. Australian Academy of Technological Sciences and Engineering, *Submission 96*, p. 3.

20 Professor Edward Byrne AC, *Submission 1*, p. 1.

21 Professor Attila Brungs, University of Technology Sydney, *Committee Hansard*, 22 April 2015, p. 1.

22 Ms Susi Tegan, Medical Technology Association of Australia, *Committee Hansard*, 24 August 2015, p. 8.

23 Ms Susi Tegan, Medical Technology Association of Australia, *Committee Hansard*, 24 August 2015, p. 11.

24 CSL, *Submission 132*, p. 5.

expressed the view that the best place to get venture capital funding for a start-up company was the United States (US) because investment in high risk or the early stages of development is not palatable in Australia.²⁵ In addition, Mr Bagnall argued that Australian superannuation funds could be provided with incentives to invest in local innovation projects, including start-ups:

Australian super funds under management now exceed \$2 trillion and are the fourth largest in the world. Virtually none of these funds are directed towards early stage high-growth companies. This lack of capital is, in my mind, the biggest hurdle in stimulating the innovation economy in Australia. While I understand that investments in high-risk technology companies are unpalatable, I also realise that underfunded start-up companies have a low chance of scaling on a global basis.²⁶

2.21 This view was echoed by Dr Krystal Evans, the CEO of BioMelbourne Network, a peak industry forum representing the Victorian biotechnology industry. In her evidence to the committee, Dr Evans observed that removing barriers to investment by venture capital firms, including superannuation funds, has been successful in countries that are comparable to Australia in terms of economies of scale. In view of the high value of Australian superannuation funds, a range of opportunities exist to link Australia's innovation sector with local venture capital. As Dr Evans explained:

This has been a successful approach for countries of similar economies of scale. For example, Canada's venture capital industry is nearly four times the size of Australia's, and is driven, in part, by local pension funds. With a value of around US\$1.62 trillion, managed funds represent an opportunity to invest in Australian innovation, offering an attractive return on investment to super funds as well as enhancing the greater economic landscape.²⁷

Recommendation 1

2.22 The committee recommends that the Australian Government commits to maintaining stable, coherent and effective administrative arrangements for innovation policies and programs, based on a long-term strategic framework and a target to lift investment in research and development to three per cent of GDP.

Innovation system leadership and coordination

2.23 In recognition of the need for a coordinated, coherent, whole-of-government approach to innovation, many OECD member countries have national strategic roadmaps to foster innovation and enhance economic impact.²⁸

25 Mr Trent Bagnall, Slingshot Accelerator Pty Ltd, *Committee Hansard*, 8 October 2014, p. 18.

26 Mr Trent Bagnall, Slingshot Accelerator Pty Ltd, *Committee Hansard*, 8 October 2014, p. 17.

27 Dr Krystal Evans, BioMelbourne Network, *Submission 72*, p. 4.

28 Organisation for Economic Co-operation and Development, *Innovation and Growth – Rationale for an Innovation Strategy*, p. 3, <http://www.oecd.org/science/inno/39374789.pdf> (accessed 19 November 2015).

2.24 Leadership is required to drive Australia's innovation agenda through mechanisms which build culture and capability while supporting collaboration. As the Chief Scientist noted, the Australian Government has the opportunity to lead the widespread cultural change that is required to achieve an innovation future.²⁹ The OECD observed that:

Implementing reforms to foster innovation may prove difficult. Strong political leadership and efforts to develop a clear understanding by the various stakeholders of the problems and the solutions – including the costs they involve – can all help to communicate the need for reform and facilitate acceptance.³⁰

2.25 In terms of governance, the point was made that there needs to be leadership across the whole value chain, not only in relation to investment in employment or research.³¹ Evidence to the committee emphasised the need for government to act as a guide and facilitator in innovation. Dr Geoff Garrett and Professor Mark Dodgson noted in this regard that government is the 'only part of Australia's innovation system that can take an overall view, and consciously shape its future direction'.³² Further, the Chief Scientist observed that:

Innovation performance and national competitiveness can be enhanced through a forward-looking, long-term and whole-of-government strategy.³³

2.26 Australia's innovation system was described in evidence as comprising 'disjointed fragments that do not add up to a comprehensive system'.³⁴ At the same time, comparatively little government funding is directed at networking and connectivity which are the core elements of an innovation ecosystem.³⁵ As a means to address this, the Chief Scientist noted that:

A successful innovation strategy will encompass the many interdependent parts of the ecosystem. It will be a whole-of-government agenda, linking the needs in different sectors of the economy to the capabilities in which the government invests.³⁶

2.27 It was noted in evidence that Australia is listed as last by the OECD in relation to collaboration between innovation-active firms and education institutions and that good work is 'lost in translation', failing to make an impact on jobs, wealth

29 Chief Scientist for Australia, *Submission 20*, p. 4.

30 Organisation for Economic Co-operation and Development, *Innovation and Growth – Rationale for an Innovation Strategy*, p. 5.

31 Ms Susi Tegen, Medical Technology Association of Australia, *Committee Hansard*, 24 August 2015, p. 8.

32 Dr Geoff Garrett and Professor Mark Dodgson, *Submission 149*, p. 2.

33 Chief Scientist for Australia, *Submission 20*, p. 1.

34 Innovation and Business Development Pty Ltd, *Submission 29*, p. 6.

35 Innovation and Business Development Pty Ltd, *Submission 29*, p. 9.

36 Chief Scientist for Australia, *Submission 20*, p. 3.

creation or improved quality of life. In light of the need for greater coordination, the view was put that government could play a critical role in driving collaboration and in providing the transformational leadership required.³⁷

2.28 The point was also made that achieving greater coordination in relation to policy and programs requires a driver. The view was taken that an independent government agency be established to administer and drive this whole-of-government approach. Such a body would be responsible for maintaining a continuous and consistent approach to innovation policy across government agencies. It would work across portfolio boundaries to achieve an integrated government approach to innovation.

2.29 The committee recognises the importance of a continuous and consistent approach to innovation across the whole of government. Such an approach would enable greater policy alignment within the current system, the identification of gaps, and would promote policy consistency over time. The committee also takes the view that a central, coordinating lead agency is essential if Australia is to have a coherent and effective innovation system.

2.30 As innovation can no longer be viewed as an adjunct to economic policy and growth, government leadership is required to place innovation at the centre of efforts to achieve sustained economic growth. Furthermore, as the Business Council of Australia noted, now is the time to move beyond a continual redefining and researching of innovation.³⁸ A government-driven approach to innovation which supports the creation of an environment and culture that incentivises innovation and enables risk taking is fundamental. Such an approach should not only articulate the interconnection of policies involved in the innovation system but also engage stakeholders in undertaking policy foresights, setting innovation policy and developing early responses to challenges and opportunities.

2.31 The committee recognises the importance of a continuous and consistent approach to innovation across the whole of government. Such an approach would enable greater policy alignment within the current system, the identification of gaps and promote policy consistency over time.

Recommendation 2

2.32 The committee recommends the establishment of an independent government agency with a mandate to administer and coordinate innovation system policies and programs. Such a body would be responsible for maintaining a continuous and consistent approach to innovation policy across the whole of government.

Strategic approach to building innovation capability

2.33 The process of innovation – which can be summarised as the translation of an idea or invention into a good or service that creates value – is central to the production

37 Dr Geoff Garrett and Professor Mark Dodgson, *Submission 149*, p. 1.

38 Business Council of Australia, *Submission 175*, p. 3.

of a range of economic, social, cultural and environmental benefits.³⁹ A fully effective innovation system, which is successful at both facilitating research breakthroughs and making them commercially viable, requires a comprehensive strategic perspective. The need for a coherent strategic perspective, especially on the part of government, was repeatedly raised throughout the inquiry. For example, Dr Geoff Garret and Professor Mark Dodgson pointed out that:

Government can act as a guide and facilitator in innovation. Investments in research, education and skills and infrastructure are crucial, but government can value add beyond this. Government is the only part of Australia's innovation system that can take an overall view, and consciously shape its future direction. To do so, it must see Australia's poor innovation performance as a systems failure.⁴⁰

2.34 As a number of submitters pointed out, including the Australian Chief Scientist, Professor Chubb, Australia possesses many advantages as a destination for investment in innovative technologies and industries.⁴¹ These natural advantages, however, have not always been translated into a corresponding increase in the levels of innovation seen in this country.

2.35 In a recent international comparison conducted by the OECD, Australia fell behind some of its major competitors, including the US and Germany, with a relatively poor innovation efficiency ranking of 81st of 143 nations.⁴² Moreover, Australia is one of only three nations to fund research and development activities, both within academia and in industry, without basing those investments on an overarching innovation strategy.

2.36 As Professor Chubb's submission makes clear, Australia's capacity to transform the fruits of its research and development activities into new products, services and processes remains limited by structural barriers, including the lack of strategic coordination by government.⁴³ As the OECD has stated:

...there is a realisation that a co-ordinated, coherent, 'whole-of-government' approach is required.⁴⁴

2.37 A number of submissions to the inquiry, including Professor Chubb's, made it clear that the lack of a 'whole-of-government' approach to innovation strategy is one of the major reasons that this country has struggled to translate its high calibre research and development achievements, in both academia and industry, into innovation efficiency and effectiveness. Submitters identified a range of structural

39 CSIRO, *Submission 36*, p. 4.

40 Dr Geoff Garret and Professor Mark Dodgson, *Submission 149*, p. 2.

41 Chief Scientist for Australia, *Submission 20*, p. 2.

42 Chief Scientist for Australia, *Submission 20*, p. 2.

43 Chief Scientist for Australia, *Submission 20*, p. 2.

44 Organisation for Economic Co-operation and Development, *Innovation and Growth – Rationale for an Innovation Strategy*; cited in Ernst & Young, *Submission 52*, p. 3.

barriers that make it difficult to unite Australia's research success with effective innovation, including: an aversion to risk taking behaviour; an impeded flow of people and ideas; and a lack of integration between the public and private sectors.⁴⁵

2.38 In relation to the structural and strategic barriers that currently inhibit innovation in Australia, the CSIRO pointed out that a critical aspect of making investments in research and development productive, let alone commercially viable, is the free flow of knowledge, particularly within the private sector. Just as importantly, the flow of knowledge between the public sector, especially universities, and private industry is a significant determinant of innovation success.⁴⁶

2.39 However, while Australia's overall research workforce is average in size for a country with a population base of nearly 24 million people, with approximately four scientists and engineers for every thousand people, only 30 per cent of this country's research and development workforce is employed in industry. Compared to other advanced economies – such as the US, where the rate of employment in industry is closer to 80 per cent – Australia rates poorly on the level of industry-led innovation.⁴⁷

2.40 In its submission to the inquiry, the CSIRO noted that this imbalance has a negative effect on the overall capacity of industry to absorb and generate new ideas. A 'silo-effect' is very much in play:

Australia...compares particularly poorly with innovation powerhouses US and Japan who have almost 80 per cent of their R&D workforce in industry. This low percentage not only limits the ability of Australian industry to undertake its own R&D activities but also limits business-to-business collaboration and business-to-research organisation collaboration.⁴⁸

2.41 Given the imbalance in the distribution of Australia's research and development workforce, which forms one of the key barriers to collaboration between the private and public spheres, the CSIRO suggested that a 'dual' strategy is likely to be the most successful in addressing Australia's innovation shortfall: firstly, strategies should be put in place to grow in-firm capacity for research and development in Australian technology companies; and, secondly, the levels of business-to-business and business-to-researcher activity will also require a significant expansion.⁴⁹

2.42 The CSIRO also pointed out that an effective innovation strategy – which would have to be co-ordinated by the Commonwealth Government – requires that a greater proportion of this country's national investment is directed towards industry-

45 Department of Industry, *Submission 110*, p. 5; Ernst & Young, *Submission 52*, p. 3; Community and Public Sector Union (CPSU) and CSIRO Staff Association, *Submission 159*, p. 5; Chief Scientist for Australia, *Submission 20*, p. 2; Engineers Australia, *Submission 46*, p. 8.

46 CSIRO, *Submission 36*, p. 6.

47 CSIRO, *Submission 36*, p. 6.

48 CSIRO, *Submission 36*, p. 6.

49 CSIRO, *Submission 36*, p. 6.

led models. These forms of investment will assist large, globally connected firms to invest in significant research and development activity:

It is these larger Australian-domiciled firms and multi-national corporations that drive a disproportionate level of R&D activity and innovation; and that provide access to global supply chains for Australia's SME's and researchers. Additional support mechanisms are also required to encourage engagement with the global innovation supply chain.⁵⁰

2.43 Echoing the CSIRO's call for a coherent and co-ordinated strategy to build Australia's capacity for innovation, the University of Melbourne pointed out that one of the key barriers to innovation is the gulf that continues to separate the university system from the private sector. This is especially noticeable and damaging on a cultural level:

While research will have relevance to industry, at time opportunities are missed. Leveraging the research capacity for business requires a better understanding of culture and capabilities between different industry sectors and universities.⁵¹

2.44 In order to bridge the gap, which is often cultural in character, the University of Melbourne suggested that one of the most effective mechanisms to ensure collaboration and integration between the university system and the private sector is co-location. In practice, this would require the creation of precincts, such as the Science Park at the University of Cambridge, where the co-location of expertise could produce a range of inter-disciplinary and cross-sectoral approaches. This would help to ensure, for example, that research projects are co-designed by the end-user:

Precincts enable the co-location of expertise at critical mass to drive interdisciplinary and cross-sectoral approaches, ensuring projects aim for powerful outcomes and are co-designed by the end user. Silicon Valley is widely regarded as the global hub for innovation, but other cities such as Tel Aviv, London and Berlin have developed innovation ecosystems that bring together research and higher education institutions and industries to accelerate innovation.⁵²

2.45 The lack of integration and collaboration between universities and the private sector, which greater co-location might help to remedy, also produces the consequence that Australian universities do not, as a rule, regard industry as a source of support for research and innovation.

2.46 Professor Deborah Hodgson, the Pro Vice-Chancellor Research and Innovation at the University of Newcastle, explained that, in 2013, the research income of the university was \$172 million, of which only \$50 million was industry related. The manner in which universities recognise and reward performance, and the

50 CSIRO, *Submission 36*, p. 7.

51 The University of Melbourne, *Submission 146*, p. 4.

52 The University of Melbourne, *Submission 146*, p. 2.

implications of this on incentivising greater collaboration with industry, were central to the inquiry. Professor Hodgson elaborated:

You have got academic researchers who have worked historically to get publications to receive grants through these competitive grant schemes, and also researchers get promotional credibility through the number of journal publications that they get and the number of grants that they get through the competitive grant schemes. They do not usually get reinforced or get incentivised for the number of patents they deliver, the number of dollars they bring in through industry grants. It is a cultural shift that has to occur at the university level but also through government schemes supporting universities to try and incentivise university faculties to work in that space.⁵³

2.47 In addition to the challenge of creating the necessary incentives to produce effective collaboration between industry and the university system, Professor Hodgson also pointed out that concerns over intellectual property have hampered efforts to link university research and private sector commercialisation. She explained that the barriers are often cultural and professional in character:

For a lot of academics, working with industry has been seen as a barrier to productivity. They see that their intellectual property can be tied up for long periods of time and it can restrict the time in which they can get their publications out. For promotion, for academic progression, you need to be seen producing a certain number of publications per year to reach your criteria to promote. Anything that slows down that ability to progress publications is, by academics, seen as a barrier for career progression.⁵⁴

Recommendation 3

2.48 The committee recommends that the Australian Government, as part of its long-term innovation strategy, includes policy options to address the structural and strategic barriers that inhibit innovation, including: measures to enhance collaboration and the free flow of knowledge between the university system and the private sector; increasing the size of the research and development workforce employed in industry; and ensuring that public funding to support science, research and innovation is long-term, predictable and secure.

Local and regional innovation ecosystems

2.49 The committee was informed that a recent World Economic Forum report highlighted that Australia's start-up ecosystem is lagging behind those of many other developed nations. Reasons include a lack of emphasis on entrepreneurship and education, limited engagement with universities and a poor culture of support for entrepreneurs. The Australasian Information Industry Association noted in this regard that:

53 Professor Deborah Hodgson, University of Newcastle, *Committee Hansard*, 8 October 2014, p. 3.

54 Professor Deborah Hodgson, University of Newcastle, *Committee Hansard*, 8 October 2014, p. 6.

Entrepreneurialism will drive innovation and create jobs and account for over half of all employment creation in G20 countries, so we need to seize the opportunity presented by innovation and move from a position where we are laggards to leaders in this part of the economy.⁵⁵

2.50 Evidence to the committee highlighted the challenges for entrepreneurial start-up companies in securing adequate venture capital. Between 2003 and 2013, the US invested US\$285 billion compared to Australia's US\$4.5 billion.⁵⁶ Investors in the US are expected to put \$84 billion into local start-up firms in 2015 while Australian investors are forecast to put in \$250 million.⁵⁷

2.51 A thriving venture capital industry was recognised as a key component of an innovation ecosystem, which not only supports start-ups but also serves as a major means of attracting entrepreneurs overseas.

2.52 In its submission to the inquiry, Charles Sturt University, one of Australia's leading regional universities, pointed out that the development of local and regional innovation ecosystems is closely connected with the goal of regional development. Importantly, the factors that help to shape local and regional innovation ecosystems, such as learning capability, research and development intensity and inter-firm relationships, are all variable across different regions. As a consequence, there is no possibility of a 'one-size-fits-all' approach.⁵⁸

2.53 In its evidence to the committee, Charles Sturt University also observed that the creation of local and regional innovation ecosystems faces a major hurdle, which can be summarised under the heading of the 'Regional Innovation Paradox'. This barrier to effective innovation at a regional level is a consequence of the greater need to fund innovation in lagging regions, along with those regions' lower capacity to absorb effectively public funds that are intended to promote innovation.⁵⁹

2.54 According to the evidence presented by Charles Sturt University, there is a clear connection in poorer regions between the higher levels of funding required to increase the competitiveness of firms and a lower capacity to absorb the funding that is directed at promoting innovation:

55 Ms Suzanne Campbell, Australian Information Industry Association, *Committee Hansard*, 22 April 2015, p. 10. The AIIA represents over 400 member organisations nationally, including hardware, software, telecommunications, information and communications technology (ICT) services, professional services and R&D organisations.

56 PricewaterhouseCoopers, *Funding Australia's future: innovation & digital technologies*, 16 April 2014, <http://www.pwc.com.au/press-room/2014/innovation-digital-technologies-apr14.html> (accessed 18 November 2015).

57 Neal Woorich, 'Venture capital drought threatens Australian economy', *ABC News*, 11 August 2015, <http://www.abc.net.au/news/2015-08-11/venture-capital-drought-threatens-australian-economy/6687992> (accessed 18 November 2015).

58 Charles Sturt University, *Submission 6*, p. 5.

59 Charles Sturt University, *Submission 6*, p. 5.

...the more innovation is needed in poorer regions to increase competitiveness of the firms, the more difficult it is to absorb public funds for the promotion of innovation in those regions...Lagging regions tend to under invest in research and development and innovation activities and appear to face difficulties in utilising public resources for innovation...Businesses do not demand innovation inputs and the research and technological infrastructure is not embedded in the regional economy...Hence a fragmented Regional Innovation system.⁶⁰

2.55 While there is no straightforward solution to the fragmentation that is often seen in local and regional innovation ecosystems, Charles Sturt University pointed out that the funding arrangements that are currently in place for rural research and development corporations are particularly successful. At present, revenue from industry levies is matched by Commonwealth funding. This form of co-funding acknowledges that a combination of private and public benefits flow from the research that is funded by this arrangement. As Charles Sturt University's submission makes clear:

The model provides for industry to have a say in guiding research priorities and directing public investment to priority areas. The close involvement of industry also provides for greater likelihood of the application of the research in practice. The Australian Research Council plays a strong role in facilitating research collaboration through Linkage Projects. There is also an ongoing fundamental role for the Australian Research Council to support pure research across all disciplines.⁶¹

2.56 The committee recognises the fact that regional innovation ecosystems can act as a catalyst for industry development and transformation, through start-ups, business and research networks and infrastructure. Therefore, it recommends that the Australian Government work with the states and territories as part of a collaborative effort to support local and regional innovation ecosystems.

Recommendation 4

2.57 The committee recommends that the Australian Government, working in collaboration with State and Territory governments, adopt a range of measures to support the role of local and regional innovation ecosystems.

Education for an innovation future

2.58 Evidence to the committee highlighted that education in entrepreneurship is limited. In addition, the committee heard that the linkages between the sciences, both pure and applied, and the humanities are inherently important for effective innovation. Moreover, such linkages are vital for the development of new and innovative technologies.⁶²

60 Charles Sturt University, *Submission 6*, p. 5.

61 Charles Sturt University, *Submission 6*, p. 5.

62 Mr Trent Bagnall, Slingshot Accelerator Pty Ltd, *Committee Hansard*, 8 October 2014, p. 17.

2.59 A recent New Work Order report by the Foundation for Young Australians found that many young Australians are not being prepared for the future. The report concluded that 35 per cent of 15 year olds are not digitally proficient; 30 per cent are not financially literate; and almost one third lack sufficient problem solving skills.⁶³ In stark contrast, an estimated 75 per cent of future jobs will require expertise in science, technology, engineering and mathematics (STEM) disciplines, while 90 per cent of future jobs will involve digital literacy.

2.60 Furthermore, the report highlighted that, at present, almost two-thirds of Australian students are being trained for jobs that will either no longer exist in the future or will be totally transformed beyond recognition. According to the study, 58 per cent of students, along with 71 per cent of vocational education students, are on a career path that may disappear or be fundamentally rerouted.⁶⁴

2.61 Much of the evidence presented to the inquiry focused, in a general sense, on the centrality for innovation of the STEM disciplines. For example, the Chief Scientist for Australia, Professor Chubb, wrote that a reliance on STEM is 'at the core of almost every national innovation agenda'.⁶⁵

2.62 However, while the importance of STEM was widely recognised, some submissions questioned the sole focus on these disciplines and instead highlighted the contribution of design and the creative industries.⁶⁶ The submission from the UTS also argued that design-led innovation complements technology-driven innovation.⁶⁷

2.63 The Council for the Humanities, Arts and Social Sciences and the Australasian Consortium of Humanities Research Centres noted that, despite many calls to extend Australia's innovation system to include the humanities, arts and social sciences (the HASS sector), innovation policy remains firmly focused on the STEM sector. They identified three ways in which the HASS sector contributes to

63 Foundation for Young Australians, New Work Order, November 2015, <http://www.fya.org.au/wp-content/uploads/2015/11/How-young-people-are-faring-report-card-2015-FINAL.pdf> (accessed 19 November 2015).

64 Rick Morton, 'Two-thirds of students 'chasing careers that won't exist'', *The Australian*, 24 August 2015.

65 Chief Scientist for Australia, *Submission 20*, p. 1.

66 For example, a joint submission from the Council for Humanities, Arts and Social Sciences (CHASS) and the Australasian Consortium of Humanities Research Centres (ACHRC) argued that the disciplines they represent contribute to innovation by: facilitating the application of STEM research; fostering a climate of innovation (by encouraging free thinking and creativity); and translating ideas into innovation through the creative industries. As an example, CHASS and the ACHRC noted how HASS research undertaken by cognitive psychologists, linguists and marketers, among others, facilitated the further development and application of the Cochlear implant. *Submission 25*, p. 1.

67 UTS provided an example of smart wheelchair technology developed at UTS with 'the interdisciplinary interplay of health, ICT and creative industries'. UTS, *Submission 118*, p. 3.

innovation: facilitation, fostering a climate of innovation and the translation of ideas into innovations through the 'creative' industries.⁶⁸

2.64 The joint submission from The Council for the Humanities, Arts and Social Sciences and the Australasian Consortium of Humanities Research Centres also observed that the successful commercialisation of STEM-led research often relies – in an implicit but significant sense – on the knowledge and understanding provided by HASS scholarship. The authors of the submission, Emeritus Professor Steven Schwartz and Associate Professor Robert Phiddian, pointed out that an innovation that might appear, on the surface, to be entirely dependent on research in the STEM disciplines will often be anchored by HASS scholarship:

...consider the complex issues of land and water use in the Murray Darling Basin. Despite working with the world's best hydrology and soil science, scientists will not be able to implement a successful water conservation regime without understanding the values and needs of the people and communities involved. What seems on the surface to be a set of technical issues is really an amalgam of the history of Indigenous and European settlement, sociology, demography, individual and group stories and a "sense of place". Without the cultural and social understanding provided by HASS disciplines, good science cannot successfully become applied science.⁶⁹

2.65 Importantly, while the commercialisation of research and innovation was emphasised in evidence to the committee, the view was put that pure research, including that conducted in the HASS disciplines, necessarily looks three, five or ten years ahead, and should therefore not be lumped together with commercial development and innovation.⁷⁰ Although the close connection between research, innovation and successful commercialisation was not questioned in the evidence provided to the committee, the vital importance of pure research, conducted for its own sake, was highlighted by a number of submitters. In its submission, for example, UTS suggested that:

It is essential that the Government continues to provide an avenue (i.e. Category 1 funding) that deliberately aims to advance knowledge and is assessed through a peer-review process that is, to some extent, agnostic of the "demand pull". Not only is this good for each discipline area, it is essential for Australian society and culture to balance investment in medical and STEM disciplines with the arts, humanities, business and economics research.⁷¹

68 The Council for the Humanities, Arts and Social Sciences and the Australasian Consortium of Humanities Research Centres, *Submission 25*, pp 1–2.

69 The Council for the Humanities, Arts and Social Sciences and the Australasian Consortium of Humanities Research Centres, *Submission 25*, pp 1–2.

70 Mr Kevin Bloch, Cisco Systems, *Committee Hansard*, 24 August 2015, p. 7.

71 UTS, *Submission 118*, p. 4.

Recommendation 5

2.66 The committee recommends that the education system be accorded a central focus in the Australian Government's long-term innovation strategy, thereby acknowledging the central importance of the interplay between the STEM subjects and the humanities, social sciences and creative industries.

Senator Chris Ketter

Chair