Chapter 4

Networks and collaboration

Highly networked innovation systems allow businesses to collaborate and share ideas, resources and ideas for innovation. Australia's innovation system is weakly networked compared to other OECD countries. Collaboration between business and research is low, as is the proportion of researchers in business. Businesses with a high capacity to absorb external knowledge can more easily adopt and adapt new ideas, resulting in better outcomes. Networking and collaboration activity is essential to a high-performing innovation system. Highly networked innovation systems enable businesses to efficiently share resources, risk and ideas for innovation.⁴⁶ Collaborative innovation is associated with more novel innovations that can capture global market shares.⁴⁷ Businesses that pursue a culture of both innovation and collaboration experience compounding benefits across a range of business performance measures.⁴⁸

This chapter discusses Australia's performance on (1) general indicators of business collaboration, (2) indicators of business-to-research collaboration, and (3) measures of business absorptive capacity.

4.1 The state of business collaboration in Australia

We use the collaboration definition from the ABS BCS which is consistent with the OECD's Oslo Manual (Definition 4.1). International comparisons on business collaboration are, like the innovation data, matched to OECD business size and industry sector classifications. The biggest issue with these comparisons is that the Australian data has a single reference year such as 2012–13 while most other OECD countries have a three year reference period such as 2010–12. We are currently working with the ABS to estimate a three-year rate of innovation and collaboration to improve international comparisons.

Definition 4.1: Collaboration

Collaboration describes arrangements where partners work together for mutual benefit, including some sharing of technical and commercial risk. It is not necessary for each participant in a collaboration to benefit commercially.

This definition used in the ABS BCS conforms to the OECD's Oslo Manual and includes informal collaboration arrangements. Measures of Australia's business collaboration activity, including international engagement, are shown in <u>Tables A3</u> and <u>A4</u>. With the exception of the resources sector, the data suggests that Australia has a weakly networked innovation system. Innovation-active Australian businesses have below average likelihood of collaboration on innovation. Australian industry has low levels of international engagement with respect to trade in goods, services, intellectual property and joint R&D. Australia performs relatively well on raw commodity trade and foreign direct investment,^(h) consistent with our technological leadership in the resources sector.

Figure 4.1 shows the proportion of innovation-active product and process innovators that collaborated on innovation. In this generic measure of collaboration, the percentage of Australian businesses collaborating on innovation activities is lower than the OECD average and more than 20 percentage points below the OECD top five average.

Figure 4.1: Businesses collaborating on innovation activities (as a percentage of innovation-active businesses undertaking product and/or process innovation), 2010–12



Notes: OECD comparisons exclude businesses with fewer than ten employees. Industry core coverage includes ISIC Rev. 4 Sections and Divisions B, C, D, E, G46, H, J, K, M71–72 and 73. Australian data is for 2012–13. The OECD top five countries are Belgium, Slovenia, Denmark, Estonia and Austria.

Source: OECD (2015) Innovation statistics and indicators, http://www.oecd.org/innovation/inno/inno-stats.htm

^(h) This investment is mostly in the *Mining and Quarrying* sector.

Looking at the percentage of businesses cooperating on innovation activities with suppliers, Australia also ranks poorly (25th out of 30 OECD countries). Only 12 per cent of innovation-active businesses undertake this type of collaboration, compared with an OECD average of 21 per cent (for 30 countries), with the top five countries averaging 34 per cent. The rankings and the gap from the frontier (the OECD top five average) is even worse when comparing large Australian businesses with their OECD counterparts. Australia also ranks below the OECD average, at 20th out of 30 countries, for collaboration with customers.

Collaboration and the frequency of innovation

Figure 4.2 suggests that collaboration on innovation and the number of innovations introduced per business per year is correlated. For example, businesses that collaborated on innovation were twice as likely to develop ten or more innovations in 2014–15.

When the data is disaggregated by business size there are notable differences between SMEs and large businesses. While large businesses tend to develop a higher number of innovations, collaboration activity did not have a significant effect on the frequency of innovation. For example, 32 per cent of non-collaborators and 28 per cent of the collaborators (on innovation) undertook 10 or more innovations respectively.

By contrast, 19 per cent of innovative SME collaborators introduced 10 or more innovations in 2014–15, almost double their non-collaborative counterparts (10 per cent). This positive relationship may reflect a general lack of resources (and risk appetite) in SMEs for undertaking a high number of innovation projects. Collaboration would allow resource-constrained SMEs to share resources and spread risks further.





Source: Customised ABS data commissioned by the Department of Industry, Innovation and Science

4.2 Business-research sector collaboration

Research institutions are a source of expert knowledge that businesses can leverage in order to innovate more effectively, both in outcomes and cost. Collaboration with research organisations such as CSIRO and universities has been found to more than triple the likelihood of businesses reporting annual productivity growth and increases in other performance measures.⁴⁹

How Australia compares

Australia fares poorly on collaboration with research institutions. Australian industry's collaboration with higher education and research institutions ranked the lowest of 27 countries in the OECD, both for large businesses and for SMEs, as shown by Figure 4.3.

For Figure 4.3, the ABS data on collaboration is matched to the OECD definition (Methodology 3.1). The surveys from which the data are derived are designed to measure the likelihood of collaborating on innovation for the entire population of businesses. They are not directed at R&D-intensive businesses, or at highly collaborative businesses. If the collaboration rates of R&D-active businesses were made the target indicator, this would not necessarily improve Australia's ranking, as all other countries would have to make a similar definitional change.

In 2012–13, the proportion of Australian non-R&Dactive product- or process-innovating businesses collaborating on innovation was 23 per cent, ranked 11th out of 30 OECD countries. The equivalent collaboration score for R&D-active businesses was higher at 32 per cent, but Australia's ranking was 25th out of 31 countries. Many other OECD countries have a higher proportion of their business population undertaking R&D than Australia, which has only about 12,000 R&D-active businesses.

The randomised, stratified sample of 7,000 businesses returns a very low proportion of businesses that are collaborating on innovation with research and higher education institutions. This means that any further breakdown by industry is not possible. Despite the volatility in the national collaboration rate, international comparisons have consistently shown relatively low rates of collaboration. Even if we crudely accounted for the difference in reference periods by tripling the rate of collaboration, Australia would still rank well below the OECD average.

A low level of collaboration using BCS data is consistent with other recorded data. In 2013-14, Australian businesses invested \$18.8 billion on R&D, but only \$426 million (2.3 per cent) was directed to higher education and \$185 million (1.0 per cent) to government in 2014–15 (Section 3.5). Much of a country's research is performed by the higher education and government sectors. Industry financing of R&D in higher education and government in Australia is average by OECD standards. Australia was ranked 16th out of 33 countries in 2012 for share in total HERD, and 12th out of 34 countries for GOVERD financing. In 2014–15, only three per cent of Australian businesses reported sourcing their ideas for innovation from higher education institutions. This suggests that the majority of Australian businesses are largely disconnected from the publicly funded research sector.

Collaboration within research organisations

Research organisations across Australia have a highly collaborative culture. In the share of the world's top one per cent of highly cited publications attributed to international collaboration, Australia was ranked 7th out of 37 OECD+ countries across all disciplines, 5th in social sciences and humanities, and 8th in natural sciences and engineering (<u>Table</u> <u>A9</u>). The rate of domestic and international researchto-research collaboration is growing.





Notes: Collaboration as a percentage of product and/or processinnovating businesses in each size category. OECD comparisons exclude businesses with fewer than ten employees. Industry core coverage includes ISIC Rev. 4 Sections and Divisions B, C, D, E, G46, H, J, K, M71–72 and 73. Australian data is for 2012–13. The OECD top five for SMEs are Slovenia, Finland, Austria, Greece and Belgium. The OECD top five for large businesses are Finland, Greece, Austria, Slovenia and Sweden.

Source: OECD (2015) Science, Technology and Industry Scoreboard 2015; Customised ABS report commissioned by the Department of Industry, Innovation and Science

Data from the National Survey of Research Commercialisation⁵⁰ shows collaboration by publicly funded research organisations (PFROs) is increasing in value terms, but is a small share of PFROs' commercialisation income (<u>Table A10</u>). However, other types of income such as contracts and consultancies, while not fitting the formal definition of collaboration, can involve PFROs in work with client businesses that is collaborative in nature. In 2014, PFROs earned \$1.8 billion from research contracts, consultancies and collaborations, of which \$0.3 billion (16.8 per cent) was on collaboration projects.

4.3 Absorptive capacity

Absorptive capacity (see Definition 4.2) influences innovation, business performance, and the transfer of knowledge within and between businesses.⁵¹

Over the past several decades a business' capacity to manage knowledge has increasingly been recognised as being important for competitiveness. The intensity of global competition requires businesses to build their absorptive capacity to stay at the global innovation frontier. Absorptive capacity has also been described as central in facilitating high levels of entrepreneurship, which is in turn linked to growth and competitiveness.⁵²

Definition 4.2: Absorptive Capacity

Absorptive capacity is a business' ability to identify, acquire, transform and exploit knowledge, external to the business.⁵³

In 2013 we collaborated with the Melbourne Institute of Applied Economic and Social Research to survey around 1,050 businesses on the relationship between absorptive capacity, innovation and business performance. The survey results indicated that businesses reporting a high-absorptive capacity tended to rate their innovation and financial performance very highly compared with lowabsorptive capacity businesses (Figure 4.4).

Activities such as co-patenting and joint R&D are commonly used as imperfect proxy indicators for absorptive capacity (Chapter 3). This section provides two other indicators of absorptive capacity: the *Source of ideas and information for innovation* (based on the Oslo Manual) and the proportion of *Researchers in business* (based on the Frascati Manual).



Figure 4.4: Self-reported business performance and innovation, by business absorptive capacity, 2013

High absorptive capacity businesses

Low absorptive capacity businesses

Notes: Based on a customised survey of absorptive capacity. *High absorptive capacity* businesses are the top 20 per cent of businesses reporting on their capacity to identify, acquire, transform and exploit knowledge external to their organisation. *Low absorptive capacity* businesses are the bottom 20 per cent. Scores are based on seven point Likert scale responses. *Inn.* = Innovation. IP = Intellectual property.

Source: Customised Survey Data from the Melbourne Institute of Applied Economic and Social Research, 2013, commissioned by the Department of Industry, Innovation and Science.

Figure 4.5: Sources of ideas or information for innovation, 2006–07 and 2014–15



Source of ideas and information for innovation

The BCS asks all innovation-active businesses the question: "During the [reference] year, from where did this business source ideas and information for the development or introduction of new goods, services, processes or methods?" Businesses are then asked to tick a range of market (e.g. customers and suppliers) and institutional sources (e.g. universities and governments).

Previous research shows that the more diverse the sources of information and ideas, the stronger the innovation performance of a business.⁵⁴ Figure 4.5 shows that this measure of absorptive capacity in Australian businesses has changed marginally over the past decade.

The majority of OECD country data on sourcing ideas is collected via the Community Innovation Survey (CIS). In this survey, businesses are asked to rate the importance of a variety of sources to their business' innovation activities. By contrast, the ABS does not ask Australian businesses to rate the importance of each source. Because the CIS ratings are qualitative and subjective, the following two international comparison figures may be subject to risks of bias and misinterpretation. Despite this issue, both figures are generally consistent with other data on networks and collaboration.

For all countries in the OECD, market sources are considered more important than institutional sources, and are more likely used as sources of ideas or information for innovation. Australian businesses, at 68 per cent, rank reasonably highly in networking with external market sources such as customers and suppliers (4th out of 24 OECD countries; Figure 4.6).⁵⁵ Australian businesses, at 6 per cent, rank reasonably poorly in networking with external institutional sources such as universities (19th out of 26 OECD countries; Figure 4.7).

Source: ABS (various) *Innovation in Australian Business*, cat. no. 8158.0

Figure 4.6: Businesses citing market sources as highly important for innovation, 2010–12



Notes: The OECD top five are Turkey, Israel, Switzerland, Australia and Slovenia. OECD comparisons exclude businesses with fewer than ten employees. Industry core coverage includes ISIC Rev. 4 Sections and Divisions B, C, D, E, G46, H, J, K, M71–72 and 73. Australian data is for 2012–13.

Source: OECD (2015) Innovation statistics and indicators, www.oecd.org/innovation/inno/stats.htm

Figure 4.7: Businesses citing external institutional sources as highly important for innovation, 2010–12



Notes: OECD comparisons exclude businesses with fewer than ten employees. Industry core coverage includes ISIC Rev. 4 Sections and Divisions B, C, D, E, G46, H, J, K, M71–72 and 73. Australian data is for 2012–13. The OECD top five are Switzerland, Israel, Hungary, Austria and the United Kingdom.

Source: OECD (2015) Innovation statistics and indicators, www.oecd.org/innovation/inno/stats.htm



Researchers in business

The more a business invests in R&D activities, the better it will be at adopting innovations and deriving profit from these activities. Using the proportion of researchers in business as a rough proxy for private sector absorptive capacity shows that Australia has low absorptive capacity by OECD standards. The total number of business R&D FTE personnel per thousand employment in industry was 9.4 in 2013.⁵⁶ Australia ranks 19th out of 33 countries on this measure. The Australian figure is below the OECD average of 9.8, and well behind the top five OECD countries' 19.2. However, there are signs of improvement. Australia has grown at an average annual compound growth rate of 6.0 per cent since 1981, from a low base of 1.6 business R&D FTE personnel per thousand employees.

The total number of business researchers (FTE) per thousand employment in industry was 4.7 in 2013.⁵⁷ Australia ranks 18th out of 33 countries on this measure. The Australian figure is below the OECD average of 6.3, and well behind the top five OECD countries' average of 14.7.

Figure 4.8 also shows that Australia has a belowaverage proportion of its total researchers in the industry sector (43 per cent) by OECD standards. The OECD average is 48 per cent, with proportions ranging between 14 and 84 per cent. Most Australian researchers work in the higher education sector (44 per cent), although researchers in business have almost reached parity. In 2008, only 31 per cent of researchers worked in the business enterprise sector in Australia. The share of researchers working in Australian businesses, although still below the OECD average, has increased in recent years. As the increased share has come at the expense of the higher education sector, it may suggest that business demand for researchers is increasing. This may indicate an increasing appreciation of the benefits of collaboration within the business sector. Historically in Australia, it has appeared as though businesses have undervalued collaboration because they do not have the capacity to understand what economically useful knowledge is outside of the business, particularly knowledge found in universities and other research organisations. This would be the case for the majority of businesses in Australia, as R&D investment is unevenly distributed.

The share of researchers working in government has remained relatively stable. In 2008, government

researchers accounted for nine per cent of the total, whereas in 2012–13 it had only increased to 10 per cent.

The absorptive capacity of Australian businesses may be further limited by a highly uneven distribution of researchers within the private sector. Data from the 2011 *Census of Population and Housing* show that engineering and PhD graduates were highly concentrated within a few sectors of the economy. Many industries in the private sector employ very low percentages of PhD graduates, with the majority of them filling management or technical roles in their sector of employment.





Notes: Data are shown as full-time equivalent. For a number of countries, methodological improvements were adopted over the period 2003–13, which may hinder data comparisons over time. In the USA 31.3 per cent of researchers are classified as 'not elsewhere classified, estimates' which hinder data comparisons. The top five countries are: (A) Israel (2012), Korea, Japan, Sweden and United States (2012); (B) Luxembourg, Mexico (2011), Slovenia, Greece and Hungary; (C) Slovak Republic, Greece, United Kingdom, Portugal and Chile; (D) Chile, Portugal, Mexico (2011), Australia (2012–13) and Italy.

Source: OECD (2015) Research and Development Statistics Database

Understanding Australia's RESEARCH COMMERCIALISATION

Since 2000, the National Survey of Research Commercialisation (NSRC) has collected information on commercialisation in Australia's universities, medical research institutes (MRIs) and publicly funded research agencies (PFRAs)

What is research commercialisation?



RESEARCH EXPENDITURE commercialisation starts with R&D

\$1,201m

Amount spent on research and development by unis, MRIs and PFRAs in 2014 UP 30% IN THE

UP 30% IN THE LAST 5 YEARS New technologies begin as ideas or research

COMMERCIALISATION STAFF

are employed to help the commercialisation process

TRAINING

4,879

participants in

industry skills training in 2014

UP 14% IN THE LAST 5 YEARS

helps researchers to collaborate with industry

533 dedicated commercialisation staff in unis, MRIs, and PRFAs in 2014 UP 60% IN THE LAST 5 YEARS



COLLABORATION often leads to more commercialisation

15,463 research contracts consultancies & collaborations in 2014

UP 7% IN THE LAST 5 YEARS

\$1,808m value of research contracts, consultancies and collaborations in 2014

UP 48% IN THE LAST 5 YEARS



Commercialisation transforms ideas and research into marketable products and processes

11

Economic productivity and quality of life increases

medical breakthroughs clean energy improved agricultural methods advanced manufacturing processes innovative transport technologies new mining technologies environmental technologies efficient use of resources international competitiveness employment

Visit www.industry.gov.au/nsrc for more information

economic growth quality of life

Source: National Survey of Research Commercialisation (2016)

Networking and collaboration activity is essential to a high-performing innovation system.