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Chief Economist

Australian Innovation System Report

2014

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Foreword

The Australian Innovation System Report 2014 is a report card on the health of Australian innovation—the fifth in a series of reports. It examines the entire national innovation system of Australia by taking a broad and an in-depth analysis of the elements making up that system.

Innovation in the Australian economy can only flourish where framework conditions are right. For innovation to contribute to Australia's competitiveness—and, ultimately, our living standards—it requires highly skilled and educated workers and managers attuned to their markets and the capabilities of their business.

These workers and managers also need to be in tune with the disruptive potential of new technologies and market movements. The changes in the world economy present danger for businesses wedded to outdated models, but also offer great opportunities for those willing to embrace the challenge of market-oriented innovation.

Unlocking innovation lies not just in the capacity of individuals and businesses to invent. An effective innovation system also requires them to be able to talk to one another. For innovation to lead to commercial outcomes that maximise competitiveness and productivity, businesses need to collaborate with other businesses in their supply chain, with researchers in universities and research agencies like the CSIRO, and with government. In short, they need to collaborate with all entities that can assist them to know more about what their customers want and how to supply it.

The complexity of framework conditions, networks and innovation activities requires a system approach to analyse Australian innovation. Drawing on data from the Australian Bureau of Statistics, the Organisation for Economic Co-operation and Development and other sources, along with case studies of innovative Australian companies and feature articles by noted thinkers, this report presents innovation and the innovation system in Australia in all its rich complexity. It examines where Australia is doing well, where we can improve our performance and what the drivers of that improvement might look like.

The theme of this year's Australian Innovation System Report is competitiveness. I trust it will once again add to the evidence base and the debate around what can best drive the health of Australian industry at a time of significant structural change.

Mark Cully
Chief Economist
Department of Industry

Australian Innovation System Report 2014

DECEMBER 2014

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Executive Summary

This 2014 report is the fifth in the Australian Innovation System Report series. The series monitors the performance of our innovation system over time, allowing emerging issues to be identified. Each report builds on data and insights from previous reports, employing both quantitative and qualitative approaches to measuring innovation.

In this report, we focus on competitiveness, considering the question: How does innovation support the competitiveness of Australian industry? Innovation, and a healthy innovation system, is vital to Australia's economy. Innovation is a major tool for creating and capturing value for a business and its customers, which translates into increased productivity and profitability. This gives businesses a competitive advantage in the domestic or global market that, when aggregated, drives sectoral and national competitiveness, and the productive re-allocation of resources throughout the economy. When we also consider national business management culture and various policy settings, we can build a picture of Australia's competitiveness and the importance of innovation.

Broadly, we find that Australia's innovation system is a mid-range performer among Organisation for Economic Co-operation and Development (OECD) countries. The evidence suggests that our innovation performance is lagging, potentially leaving us less resilient to future global shocks. These findings are further outlined below.

Innovation matters for business and national competitiveness

There is strong empirical evidence that innovation has a positive impact on the economy and the competitiveness of Australian businesses.

Business innovation is about implementing change in a market and staying competitive. The proportion of employing businesses that were innovative was 42% in 2012-13. In that same year these innovative businesses accounted for around a 70% share of the economy's employment, capital expenditure and business income and more than 80% of total internet income.

Innovation also drives business performance at the firm level. Compared with businesses that don't innovate, innovative Australian businesses report that they are:

We wouldn't exist without innovation

—Ben Bartlett,

Lumen Australia

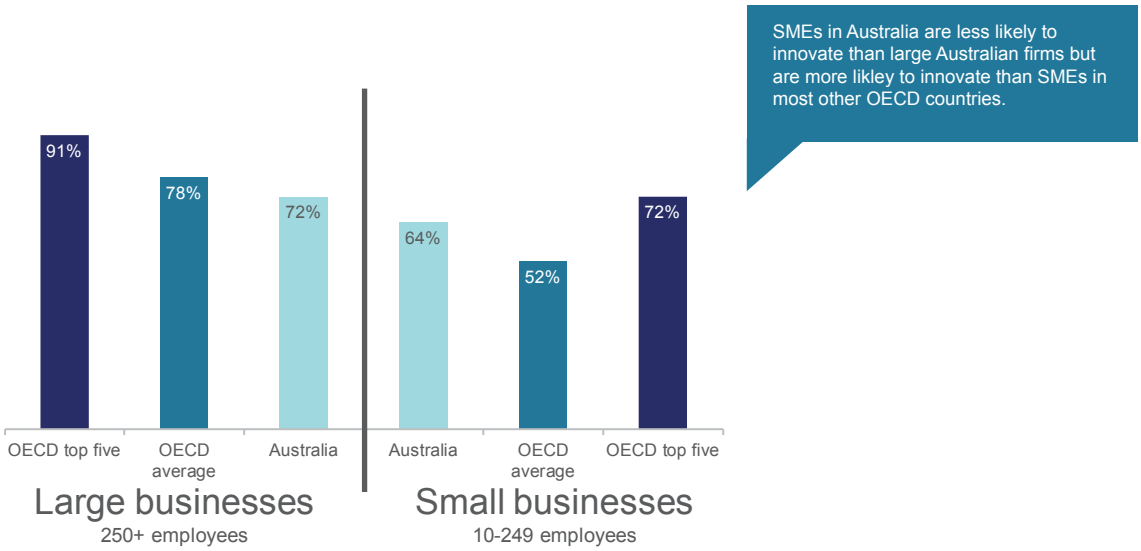
- 31% more likely to increase income and 46% more likely to report increased profitability
- twice as likely to export and five times more likely to increase the number of export markets targeted
- twice as likely to increase productivity, employment and training
- three times more likely to increase investment in information and communications technology
- three times more likely to increase the range of goods and services offered.

These survey results have been consistent across all business sizes and sectors suggesting that innovation is an effective tool to grow a competitive business. In fact the data shows that there is a significant positive association between innovation and recorded sales performance. Between 2009-10 and 2011-12, median annual sales growth for non-innovators was $4,245. By contrast persistent innovators (those that innovated in all three years) had the highest median annual sales growth of $243,764. Controlling for size, data shows that between 2007-08 and 2011-12, average gross profit per employee was $20,400 for innovative businesses. This was 47 per cent higher than businesses that don't innovate at $13,900.

Australian firms are innovative but, on average, Australia's exporters perform relatively poorly on innovation

Despite generally positive business conditions for innovation and evidence of the benefits of innovation to business performance, the report shows that Australian exporters are, on average, not high performers of innovation by OECD standards. Our large businesses account for around 66% of investment in research and development (R&D), 44% of industry value-added and around 95% of exports. However, Australian large businesses rank 21st out of 32 OECD countries on the proportion of businesses innovating, and are well below other less developed resource-exporting countries like Brazil and South Africa (see figure below).

In contrast to large firms, Australian small to medium-sized enterprises (SMEs) are innovative by OECD standards, ranking 5th out of 29 OECD countries on the proportion of businesses innovating. This is a positive result, given that SMEs account for 56% of industry value-added. Australian SME manufacturers ranked 5th in the OECD on innovation, while Australian SME service sector businesses ranked 7th. These innovative SME firms account for 5% of Australia's direct exports. Qualitative evidence provides many examples of Australia's innovative SMEs supporting large Australian exporters through local supply chains, but more could be done to help these businesses overcome barriers to trade and access global value chains.



Australian firms lag in new-to-market innovation

Not all innovation is the same when it comes to international competitiveness. New-to-market innovation has more impact on the competitive advantage of a business than the adoption of innovations already in the market (new-to-firm innovation). New-to-market innovation increases the likelihood of exporting up to four times that of new-to-firm innovation and two to eight times more likely than non-innovators. New-to-market innovation is also significantly associated with an increase in sales (between 22% and 68%).

However, the predominant innovation that occurs in Australian firms of all sizes is the adoption and modification of innovations developed elsewhere, rather than delivering new-to-market (including new-to-world) innovations. Only 5.7% of Australian businesses introduced new-to-market innovation in 2012–13. Australia ranks poorly compared to European Union countries on new-to-market goods and service innovation (9%), well behind countries like Germany (17%) or Sweden (26%). Our degree of new-to-market innovation appears to have declined in the past ten years. Australia's relatively poor levels of new-to-market innovation will limit industry attempts to build international competitiveness and increase participation in global value chains.

Innovation comes not just from the product but the look and feel of the company.

—Anton Pemmer, Bottles of Australia

Australian business conditions support innovation, competitiveness and investment

The data suggest that Australia's regulatory environment, research capacity and skills base provide a generally favourable framework for entrepreneurship and innovation. Australian rates of business creation remain high by world standards, ranking between 1st and 5th depending on the measure used. Australia ranks second only to the United States (US) on the rate of innovation-driven entrepreneurship.

The most commonly identified barrier to innovation in Australia is a lack of access to additional funds (20.3% of all businesses). Although venture

capital investment remains low by OECD standards, in recent years, Australia has performed well in attracting foreign investment, ranking 13th in the world in 2012 on its stock of foreign direct investment. Australia's stock of foreign direct investment rose from US$150 billion in 2002 to US$611 billion in 2012—a four-fold increase to 39% of gross domestic product (GDP) in 2012. Much of that investment is directed towards the mining sector.

Investment in innovation is dominated by large firms

For Australian businesses that reported expenditure on innovation in 2012–13, the Australian Bureau of Statistics (ABS) estimated total expenditure of between $28 billion and $34 billion, an increase on the $23 billion to $29 billion estimated for 2010–11. ABS data show that investment in business R&D was $18.3 billion in 2011–12, of which $11.4 billion (62%) was experimental development.

Investment in intangible capital such as R&D is an important source of international competitiveness, and intangible capital typically generates the highest value in a supply chain. Intangible capital includes assets such as data, software, designs, new organisational processes, management quality, R&D, patented technology, reputation (brand equity) and firm-specific skills. Australia's stock of intangible capital was estimated at $297.4 billion in 2012.

Intangible capital investment by business accounts for between 12% to 20% of Australia's average labour productivity growth. Australia's annual investment in intangible assets is growing but still low by OECD standards. The only area of R&D investment where we exceed most other OECD countries is in primary and resource-based industries (Australia is in the top five). The ratio of intangible capital investment to physical capital investment was 42% in Australia in 2010. This compares poorly with the US at 200% and the OECD average of 82% in the same year.

Out of the two million businesses in Australia, around 9000 businesses undertake R&D. Even then the majority of total business R&D investment, which is below the OECD average, is highly skewed to a few large firms that invested 66% of the total $18.1 billion in business R&D in 2010–11.

Australia's business expenditure on R&D was 1.23% of GDP in 2011–12, ranking Australia 15th out of 34 OECD countries. Australia's R&D profile is quite different from the other OECD countries, even other resource-rich countries such as Canada and Norway, in that it has concentrated its R&D investment in primary industries, particularly the mining sector. Australian business R&D investment in manufacturing is below the OECD average, particularly in high-tech manufacturing. Food, paper and basic metals manufacturing have relatively high R&D intensities by OECD standards. Many service sectors such as finance and insurance services, and information and communication services also have relatively high R&D intensities.

Australia has several business sectors that are internationally competitive

Every business sector in Australia will have some highly innovative businesses that are competitive. Aggregate export data allow us to look at broad trends for each sector of the economy. In line with our decline in new-to-market innovation, Australia has many exporting sectors where international competitiveness is declining despite increases in their gross exports in the same period. In many cases, global demand growth is benefitting Australia, but not because of any apparent growth in our competitiveness.

This report shows evidence demonstrating the strong positive association between innovation and business, economic and export performance. To the extent that domestic competitiveness is innovation driven, Australia is a relatively strong performer. However, our international competitiveness is not supported by a weaker innovation performance by our large firms, which do 95% of our exporting (by income). Of course, this is an argument based on national averages.

Considering all industries at the highest level of disaggregation, there are 19 industries where Australia shows a disproportionately high global market share. Export data show that Australia has internationally competitive advantages in exporting agricultural and mining commodities, basic metals, food, tourism and education-related travel services. All but one of our top five comparative advantage sectors are in mining industries, including hard coal, uranium, iron and non-ferrous metal ores. The only non-mining industry is the farming of livestock and dairy farming.

Together, these 19 industry sectors accounted for 81% of our goods exports between 2008 and 2012, and 62% of our services exports between 2007 and 2011. Our participation in global value chains in these sectors is generally high.

In addition, Australia has hidden competitive trade strengths in largely domestic services that indirectly support the international competitiveness of Australia's exporters (such as manufacturing and resources) through domestic supply chains. These hidden strengths are in transport, telecommunications, finance, business and other services.

High innovation capability is found where Australia has internationally competitive industries

For this report, we have used a combination of R&D, patent and trademark data to show that there is generally a very strong alignment between a sector's innovation capabilities and its international competitiveness. There are almost no sectors in Australia that have high international competitiveness without also having relatively high innovation capabilities. Although there are some areas of apparent misalignment with high innovation capabilities and low international competitiveness (e.g. most

of manufacturing), many of these sectors are likely engaged in intense domestic competition, sometimes with high import competition.

A potentially concerning finding is that mining is the only sector with a labour productivity that is well above the OECD median. All other sectors are at or below the OECD median, and well behind leading countries. However, productivity data are not disaggregated enough to determine whether the subsectors or niche areas of international competitiveness identified in this report have relatively high labour productivity by OECD standards.

Australia is lacking in export diversity

Although Australia has a diversified domestic industrial base, this is not reflected in the diversity of its exports. Australia has considerably lower economic complexity than most advanced economies in spite of having the 6th highest income. Australia has 19 internationally competitive industry sectors (those with a revealed comparative advantage [RCA] of more than one). By contrast, comparator countries have around 35 industry sectors with an RCA greater than one. In addition, Australia's exports have become less complex in the past fifteen years. This means that Australia's capacity to be internationally competitive in a range of diverse and complex products has declined, despite some emerging export industries. We rank as one of the countries with the least diverse export profiles among the OECD.

What is holding Australia back?

A range of recent reports (e.g. by the Australian Council of Learned Academies, Microsoft Australia, Google Australia/PricewaterhouseCoopers and McKinsey/the Business Council of Australia) argue that the reason for Australia's moderate to low performance on innovation, particularly new-to-market innovation, is a poor business innovation culture, in association with an average to poor management performance. More specifically, this literature finds that the main impediments to Australia's innovation system are:

- poor networking and collaboration
- poor levels of venture and private equity capital investment in innovation
- some fragmented and/or obstructive government policies or regulations, such as tax treatment of employee share schemes, government procurement of innovation and low incentives for research commercialisation/collaboration in the public research sector
- a small geographically isolated economy dominated by small businesses and/or lifestyle entrepreneurs that are seeking local competitive advantage through cost reduction rather than pushing the innovation frontier to capture world markets through value creation
- poor business culture of innovation and risk aversion in Australia

- relatively poor business management capability, leading to underinvestment in innovation and related activities.

Australia's low level of collaboration limits our ability to diversify the economy

Networking and collaboration are fundamental to any innovation system. Businesses rarely innovate in isolation. This report shows that Australia has one of the weakest levels of networking, collaborative innovation and business capacity to absorb and exploit external knowledge among OECD countries. Compared with other OECD countries, Australia has low levels of trade, low participation in global value chains, low international collaboration on innovation, low proportions of researchers in business, and low collaboration on innovation between the research and industry sectors. Between 2006–07 and 2012–13, collaboration on innovation has remained low for SMEs while large firms have increased by 47% during the same period. However, a significant gap remains between Australia and other developed economies for collaboration on innovation. Australian SMEs were ranked 24th out of 31 OECD countries in 2008–10 for collaboration on innovation. Large firms ranked 29th.

The 'tyranny of distance' alone cannot explain this phenomenon. Other countries that are distant from the major markets of western Europe and North America—Israel, South Africa and New Zealand—are more active in international collaboration on innovation than Australia. These countries are also more integrated into global value chains.

Greater collaboration on innovation between sectors will help drive world-first innovation and global value chain participation

Our participation in global value chains is above the world median in mining, business services, transport and manufacturing of food and basic metals, and our participation has improved since 1995. Yet our overall participation in global value chains according to the OECD's global value chain participation index is below the OECD median, and well behind global value chain hub countries.

Business collaboration on innovation is significantly and positively associated with new-to-market innovation, for example a 70% increase in the chance of achieving new-to-world innovation. Poor collaboration on innovation is therefore likely to diminish Australia's ability to participate in many world-first innovations. Taken with the poor to moderate relative innovation performance of Australian firms, the capacity for Australian businesses to integrate into the higher value-added parts of global value chains is limited compared to foreign rivals.

New-to-world innovators are heavy users of science and research skills. In Australia, most of those skills are found in the public sector, particularly public research organisations. Australia's low representation of researchers in business suggests Australia should place more emphasis on improving

levels of industry–research collaboration and engendering greater workforce mobility between sectors in the short to medium term, as first steps towards becoming a global leader in innovation. Collaboration between research and industry is one of the lowest in the OECD. Industry–research collaboration on innovation by Australian SMEs is ranked 29th out of 30 OECD countries, and large firms are ranked 30th.

Australia's research strengths generally align well with our existing trade strengths. However, some research or innovation strengths remain underdeveloped. For example, the OECD has identified that Australia has strengths in general environmental management technology and technology specific to climate change mitigation, ranking 1st and 2nd, respectively, in the world share of Patent Cooperation Treaty patents. If research commercialisation and industry–research commercialisation were stronger in Australia, supported by a larger high-risk capital market, these strengths might be better leveraged into high-growth industries.

What else can be done?

Governments make indirect, complementary investments in innovation through infrastructure, research, healthy skilled workers, industry standards, corporate governance and regulatory environment policy. These indirect investments can create the right framework conditions in which business managers decide to invest in innovation. In these broad terms, Australia often ranks quite highly. Direct government assistance for innovation currently covers only around 3% of businesses in 2011, with the level of public sector support to innovating firms the lowest in the OECD, ranked 25th out of 25 OECD countries measured.

Business leaders and managers have the primary responsibility for investing in business innovation. Specific areas where managers and leaders in Australian businesses can focus their attention include:

- developing a unique understanding of local and foreign customers, suppliers and competitors, and redesigning globally oriented business models to both account for those needs and lower costs
- developing systems, processes and skills that identify international opportunities, overcome cultural barriers, and improve negotiation, planning and risk management
- building and maintaining a network of partnerships with businesses and other organisations that can collectively
  - learn from mistakes, solve problems and realise new opportunities
  - build understanding and excellence around the management of intangible assets such as skills
  - build a culture of collaborative innovation
  - build critical market scale or degree of diversification
- developing a small, manageable portfolio of high-priority innovation initiatives with ownership and commitment from senior leaders.

The report shows a strong correlation between innovation and business performance, particularly exports. Its findings suggest that investments in collaborative, world-first innovation will help capture the opportunities that emerge from the creative destruction of global markets.

1. Introduction

The Organisation for Economic Co-operation and Development (OECD) argues that—during the next 50 years—innovation and skills development, driving economic growth through productivity, will be the major counterbalance to ageing populations, climate change and rising income inequality.[1] There is a 'race to the top',[2] where nations increasingly compete for a greater share of global wealth through innovation. Innovation is a broad concept, with significant social and environmental contributions to make, much of which is hidden from national accounting. Countries around the world are only just starting to incorporate investment in innovation-related activities into their national accounts. Experimental data suggest that innovation investments and their spill over benefits could account for up to 62% of labour productivity growth in Australia.[3]

The Australian Innovation System Report shows the importance of innovation and provides a reference document that monitors the performance of the national innovation system over time.

The report, the fifth in the series, builds on findings from previous reports, and uses both quantitative data and qualitative case studies to measure and demonstrate the impact of innovation in Australia.

The report series show significant positive correlations or strong positive associations between innovation and business, industry, and macroeconomic performance. Although any one isolated dataset provides a correlation, the suite of qualitative and quantitative data contained in this report series, in conjunction with existing literature, collectively demonstrates a causal link between innovation and impact/performance measures such as productivity.

The 2014 report focuses on the interaction between innovation and competitiveness; specifically, the relationship between exporting and innovation.

1. OECD (2014) *Policy challenges for the next 50 years*, OECD Economic Policy Paper, OECD Publishing, www.oecd.org/economy/lookingto2060.htm.
2 Sainsbury D (2007) *The race to the top: A review of [UK] government's science and innovation policies*, HMSO Books, London. This year, President Obama stated, 'we know that the nation that goes all-in on innovation today will own the global economy tomorrow'. President Obama's State of the Union address, 28 January 2014, www.whitehouse.gov/the-press-office/2014/01/28/president-barack-obamas-state-union-address.
3 *Australian Innovation System Report 2011*, p. 9, www.innovation.gov.au/aisreport.

Unless otherwise stated, the report focuses on for-profit business innovation, and the private, private not-for-profit and public activities that support business innovation.

1.1 What is innovation?

Business innovation is a new idea or path that is applied practically to create or capture value in a market.[4] Innovation could start with 'How do I increase my market share?', 'How can my business model be more cost-effective?' or 'How can I reduce my environmental footprint?' Innovation can be either proactive or reactive.

Innovation is about market experimentation. It involves the acceptance or, at least, tolerance of uncertainty and the risk of failure on the basis that learning will come from failures and will ultimately lead to greater competitiveness. An economy constantly recreates itself through collective innovation, exploration and experimentation by firms searching for a dominant design that will suit the current market environment and persist for long enough to generate significant profit.[5]

To compare Australia with other countries in a systematic way, we adopt an internationally recognised firm-level definition of business innovation from the OECD:

> *Innovation is the implementation of a new or significantly improved product (good or service), process, new marketing method or a new organisational method in business practices, workplace organisation or external relations.*[6]

In this report, we examine the degree to which Australian businesses engage in innovation, including whether firms are adopting innovations created elsewhere or developing new-to-market innovations. The degree of novelty can have a big impact on the competitiveness of a business.

At minimum, an innovation must be new to the firm. Higher degrees of novelty can be broadly categorised as 'new to market'. Innovations are new-to-market when the firm is the first to introduce the innovation on its market. The market is simply defined as the firm and its competitors, and it can include a geographic region or product line. Within this category, you can have 'new to industry', 'new to country' and 'new to world' innovation. An innovation is new-to-world when the firm is the first to introduce the innovation for all markets and industries—domestic and international.

4 See also Business Council of Australia (2014) *Building Australia's innovation system*, p. 6 www.bca.com.au/publications/building-australias-innovation-system.

5 Arthur WB (2013) *Complexity economics: A different framework for economic analysis*, Santa Fe Institute Working Paper, April 2013; and Berkun S (2010) *The myths of innovation*, O'Reilly Media, Cambridge, MA.

6 OECD (2005) *Oslo manual: guidelines for collecting and interpreting innovation data*, 3rd edition, OECD and European Commission.

Box 1.1 The main types of innovation

Four types of innovation are distinguished: product innovations, process innovations, marketing innovations and organisational innovations.

Product innovation

A product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness, or other functional characteristics.

Process innovation

A process innovation is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.

Marketing innovation

A marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion, or pricing.

Organisational innovation

An organisational innovation is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations.

1.2 What is an innovation system?

Innovation arises from the combination and application of existing ideas or inventions in a market. Every dominant technology or design in society today stands on the foundations of others. For example, Apple's iPod, iPhone and iPad could not exist without the efforts of others, particularly the United States (US) Government.[7] The case studies in this report show that business is relationship driven.

The only failure that really counts is running out of cash. As long as you don't do that and as long as you learn from all the other mistakes then you'll generally be alright. You've got to keep trying. You've got to keep your eye on that massive potential venture.

—Ian Gardiner, Viocorp

At its most basic level, an innovation system is about networks of people. It is about the organisations, rules, culture and interactions people create, and how people use these elements to generate and exploit knowledge and ideas. National innovation systems reflect the coordination between different actors, activities and framework conditions to increase the innovation capability in a country.[8] Most definitions of innovation systems have three fundamental elements: innovation-related activities, networks of people, and

7 Mazzucato M (2013) *The entrepreneurial state: debunking public vs private sector myths*, Anthem Press, London.

8 Innovation systems can be studied at multiple levels, ranging from technological innovation systems, sectoral innovation systems, national innovation systems and the global innovation system.

an influential environment or culture within which these activities happen.[9] This report uses the following definition of an innovation system:

An innovation system is an open network of organisations that interact with each other and operate within framework conditions that regulate their activities and interactions. Three components of the innovation system—networks, innovation activities and framework conditions—collectively function to produce and diffuse innovations that have, in aggregate, economic, social and/or environmental value.

Networks refer to formal or informal collaborations in the innovation system, such as communities of practice of software programmers, and industry collaborative arrangements, such as the Australian Mineral Research Association, the Australian Sports Technology Network (featured in Box 1.2) and the Cooperative Research Centres.

Innovation activities are functions in the innovation system that affect innovation, such as the provision of research and development (R&D), the support of entrepreneurial activity through venture capital, or the training of scientists and engineers in tertiary education. These activities can be performed by public, private and private not-for-profit organisations.

Framework conditions are the environment and business conditions that either encourage or discourage innovation. They are a set of established practices, rules or laws that regulate the behaviour of actors in the system. Examples of framework conditions are tax breaks for R&D, trade tariffs and industry technology standards. They can also be more specific, such as the innovation culture in a particular industry sector.

Defining, measuring and comparing innovation systems present conceptual challenges. There is no innovation system theory that identifies clear boundaries of an innovation system, and there is not an optimal innovation system.[10] Innovation systems are a product of history and embedded in a country's industrial structure and institutions. Yet, innovation systems can change and, in some cases, change dramatically in just a few decades. The Business Council of Australia recognises that, to drive innovation, we need to recognise and ensure that all parts of the system are in place, the parts of the system are aligned and the system is mobilised to achieve national objectives.[11]

9 See a review of innovation systems definitions in Deloitte Access Economics and Business Council of Australia (2014) *Australia's innovation imperative*, pp. 7–8 and the appendix.

10 Edquist C (2008) *Design of innovation policy through diagnostic analysis: identification of systemic problems (or failures)*, CIRCLE Electronic Working Paper Series 06, Lund University, Lund, Sweden.

11 Business Council of Australia (2014) *Building Australia's innovation system*, BCA submission to the Senate Economics Reference Committee Inquiry into the Australian Innovation System, lodged in September 2014.

If the concept of an innovation system is to be useful for policy development, it is necessary to move from the theory and concepts to the practical/ evidence base. Generally, a mix of quantitative (indicator based) and qualitative (case study based) methods are used to present a picture of the system and its workings. This report follows that approach.

An understanding of the performance of the innovation system helps us determine our capacity for market diversification and economic renewal. As Hausmann et al. show, industry sectors have inherent differences in their ability to generate, multiply and incorporate innovative capabilities and skills.[12] Sectors that are more complex and connected—such as information and communications technology, or advanced chemicals—will have a better chance to combine their existing capabilities to develop new products and, hence, new capabilities. The development and accumulation of these capabilities, however, can take a long time. Some countries may become trapped, because the lack of complexity or remoteness of their economic activity does not allow the formation of capabilities for the creation of new products and sectors.[13]

Box 1.2 Case study: Australian Sports Technologies Network[14]

Australia and sports go hand in hand. Perhaps more than any other country, Australia could be said to have a 'comparative advantage' in sports and sports technologies. But, as Australian Sports Technologies Network (ASTN) Executive Director Craig Hill puts it eloquently, 'Australia has been globally recognised as a sporting hub for decades. Yet you can only think of a handful of Australian sports brands that have been successful in the international marketplace'.

That is basically the idea behind the ASTN. Formed in April 2012, it already has more than 150 members and is expected to grow to 300 by the end of 2015. It is based in Geelong and has a national reach across the entire 'sports ecosystem' in Australia. Sports technology is a vast field that covers sectors such as manufacturing and design, advanced materials, life sciences and information technology. The ASTN is therefore an aggregator of Australian sports technologies bringing together the major stakeholders, including manufacturers, retailers, start-ups, government, universities and sport itself through a national collaborative network.

How did the network come about? According to Craig Hill, it was—to a large extent—just a matter of joining the dots between the industry players in Australia. The seeds for development of the ASTN came from the Geelong region. For example, there was already existing research and manufacturing capability, a surf cluster at nearby Torquay and an active sporting community, so it made sense to have Geelong as a base. The network received seed funding of $225,000 from the government to kick it off. 'All the critical elements that are making it successful are there at the table', says Hill.

POD knee brace

12 Hausmann R et al. (2013) *Atlas of economic complexity: mapping paths to prosperity*, Center for International Development, Harvard University, Cambridge, MA, pp. 20–21, 29.

13 Ibid. p. 29–30.

14 Based on interview conducted on 30 May 2014.

Particularly important for growth is improving commercialisation pathways for start-ups as well as sports research. This has been lacking in the past. Angel investors and venture capitalists are now starting to invest in the sports tech industry in a coordinated fashion and Australian firms need to be aware of the potential.

An example of a new ASTN initiative is HeadStart. According to Craig Hill, this is 'the only business accelerator program in Australia that focuses on sports technology, and one of the only accelerators in the world dedicated to developing businesses in this sector'. They are aiming to put 20–25 organisations through the program in the next two years. Organisations have to specifically come to Geelong to take part in the program.

The ASTN is therefore making a real pitch to not just develop Australian expertise and know-how, but also to exploit it through products and services that reach out to grassroots consumers and are commercially viable.

'We're trying to promote the philosophy that Australia is a fantastic test bed for sports technology innovation. The international sports market is valued at around A$600 billion and deserves more focus from Australian firms', says Hill.

The ASTN is an important regional-based hub (with a national reach) that has successfully identified an industry in which we have global recognition. It is another example of innovation not just in niche sectors and products, but also in the idea that geography and clusters can make a real difference to regional transitions and economic outcomes.

1.3 Why should we innovate?

Innovation is a key factor for competitiveness and growth in a developed economy.[15] Innovation and a healthy innovation system are vital to Australia's economy if we are to maintain and improve our economic position in the face of increasing global competition, climate change and an ageing workforce. The growth accounting model developed by Robert Solow[16] in the 1950s found that labour and capital accumulation only could explain about 30% of economic growth. Solow argued that the rest of economic growth was explained by innovation (he called this black box residual the 'technical progress factor'). Similar conclusions are reached from an economic history perspective, which indicates the crucial role of innovation in explaining long-term economic growth.[17]

Investment in innovation, particularly the development of new goods and services, drives productivity growth and, therefore, the competitive

15 UN Economic Commission for Europe (2007) C*reating a conducive environment for higher competitiveness and effective national innovation systems: lessons learned from the experiences of UNECE countries,* United Nations, New York & Geneva, pp. 9–37; Urbancová H (2013) Competitive advantage achievement through innovation and knowledge, *Journal of Competitiveness* 5(1): 82–96; and OECD (2013) S*cience, technology and industry scoreboard*, OECD Publishing, p. 213.

16 Solow RM (1957) Technical change and the aggregate production function, *Review of Economics and Statistics* 39(3):312–320.

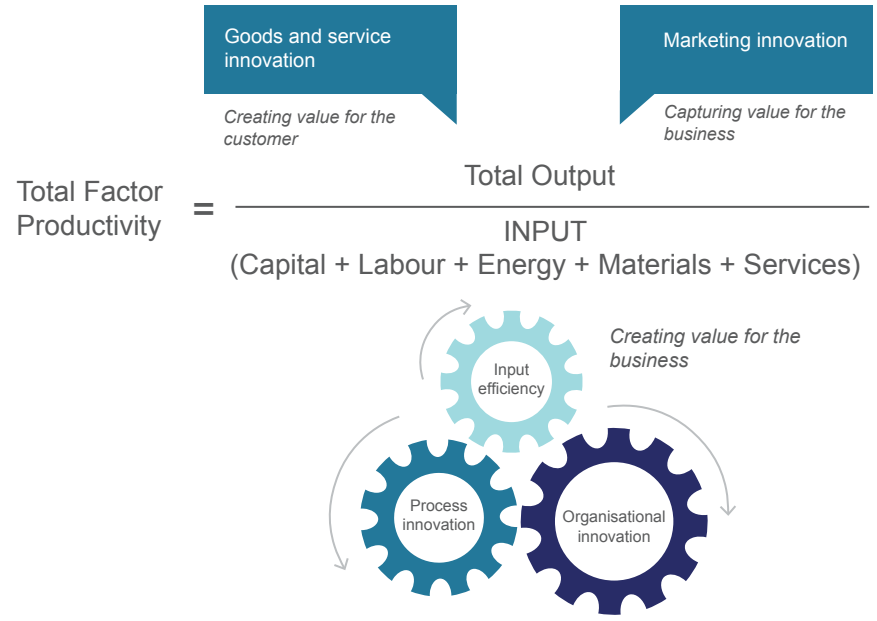
17 See Deirdre McCloskey's keynote speech at the 14th Joseph Schumpeter Conference, Brisbane, July 2012; Rosenberg N et al. 1992, *Technology and the wealth of nations*, Stanford University Press; and Verspagen B 2005, Innovation and economic growth, in: Fagerberg J, Mowery DC & Nelson RR (eds), *The Oxford handbook of innovation*, Oxford University Press.

advantage of businesses.[18] Innovations can disrupt competitive markets with radically new goods and services, or make incremental improvements. Both types of innovation can lift productivity. Experimental data suggest that innovation investments and their spill over benefits could account for up to 62% of labour productivity growth in Australia from 1994–95 to 2005–06.[19] Higher productivity in turn gives businesses a competitive advantage in the market.[20]

Market disruption comes from new goods or services, and business model innovation. Firms that deliver highly novel new-to-market goods and services create temporary monopolies that drive up profits for the firm. A competitive edge requires the production and marketing of new goods and services that are unique, not easily reproduced and that create value to the customer or capture value for the firm (Figure 1.1).

In the case of more incremental process and organisational innovation, the firm gets a cost advantage over its competitors by using resource inputs more efficiently (Figure 1.1). This allows a business to gain a higher mark-up at the prevailing market price, or to use a combination of lower price and higher mark-up than its competitors[21] to gain market share and higher profit margins.

Figure 1.1 A model of the relationship between total factor productivity and different types of innovation



18 Hall BH (2011) *Innovation and productivity*, Nordic Economic Policy Conference on Productivity and Competitiveness; Soames L et al. (2011) *Competition, innovation and productivity in Australian businesses*, Productivity Commission and Australian Bureau of Statistics Research Paper, ABS catalogue no. 1351.0.55.035, Canberra; and Hashi I & Stojčić N (2013) The impact of innovation activities on firm performance using a multi-stage model: evidence from the Community Innovation Survey 4, *Research Policy* 42:353–66.

19 *Australian Innovation System Report 2011*, p. 9, www.innovation.gov.au/aisreport.

20 Fagerberg J (2013) *Innovation: a new guide*, Working Papers on Innovation Studies 20131119, Centre for Technology, Innovation and Culture, University of Oslo.

21 Depending on the elasticity of demand.

All competitors sat on their hands during this time to save costs. We thought if we commit to improving who we are, what we are and how we do it, then that sets us up going forward.

—Anton Pemmer, Bottles of Australia

Competitive advantage at the firm level has been defined as the 'value a firm is able to create for its buyers that exceeds the firm's cost of creating it. Value is what buyers are willing to pay, and superior value stems from offering either lower prices than competitors for equivalent benefits or providing unique benefits that more than offset a higher price'.[22] In this way, innovation, productivity and competitive advantage are linked.

Productivity is the ratio of a firm's sectors or economy's outputs to inputs. There are a number of ways to measure productivity. Labour productivity is where the only input being considered is labour (e.g. hours worked). Total factor productivity, or multifactor productivity, typically uses just labour and capital inputs. The KLEMS total factor productivity[23] uses a more comprehensive account of inputs relating gross output to primary (capital and labour) and intermediate inputs (energy, materials, and other intermediate goods and services).[24] Productivity growth occurs when growth in industry outputs exceeds growth in inputs.

Just as effective innovation can be a source of competitive advantage to a business, a high-performing innovation system can be a source of competitive advantage to the Australian economy.[25] Research shows that in competitive markets innovative businesses out-compete other businesses by achieving higher rates of firm survival and growth in employment and profits.[26] Uncompetitive firms fail and their resources are re-allocated to these more productive and profitable business, resulting in allocative efficiency and, hence, increasing aggregate productivity growth across the economy.[27]

Exposure to international markets through export or import competition further encourages Australian businesses to continuously maintain and grow

22 Porter ME (1985) *Competitive advantage*, Free Press, New York, p. 3

23 OECD (2001) *OECD productivity manual: a guide to the measurement of industry-level and aggregate productivity growth*, OECD Publishing, Annex 1—Glossary.

24 Countries from around the world (not Australia) are building KLEMS total factor productivity databases. www.worldklems.net/index.htm.

25 Business Council of Australia (2014) *Building Australia's innovation system*, submission to the Senate Economics Committee Inquiry into the Australia Innovation System.

26 Bloom N, Draca M & Van Reenen J (2012) T*rade-induced technological change? The impact of Chinese imports on innovation, diffusion of IT and productivity*, National Bureau of Economic Research working paper 16717.

27 This argument is based on many evolutionary economics studies. See Nelson R & Winter S (1982) *An evolutionary theory of economic change*, Belknap Press, Cambridge, MA; and the works of Joseph Schumpeter (1934, 1942). See also Fagerberg J (2013) *Innovation—a new guide*, TIK Working Papers on Innovation Studies 2013-11-19, Centre for Technology, Innovation and Culture, University of Oslo; and Foster et al. (2005) *Reallocation, firm turnover and efficiency: selection on productivity or profitability?* NBER Working Papers 11555. Australian evidence comes from Parham D (2002) T*he role of exit and entry in Australian productivity growth*, OECD science, Technology and Industry Working Papers 2002/06, OECD Publishing; and Nguyen T & Hansell D (2014) *Firm dynamics and productivity growth in Australian manufacturing and business services*, ABS Research Paper, ABS, Canberra.

market share by being more productive. According to Lydon et al., firms with international exposure have more than double the rate of productivity growth, better management quality, and greater and more novel innovation than their domestic counterparts.[28] Trade also exposes businesses to a much wider range of ideas and solutions. By exposing themselves to the world market, innovative businesses learn from international competitors, suppliers and customers, and bring that knowledge back to Australia. This in turn generates more innovation. International research also shows that innovation is a fundamental tool for establishing and maintaining export relationships, particularly where market churn and demand for large variations in product design is high.[29]

Just like productivity, innovation is not a means to an end. Wealth, health, employment, social inclusion, social equity and environmental sustainability are facilitated by innovation in its broadest sense. It is worth briefly touching on economic and social outcomes, as they will, in part, reflect past performance on innovation. Australia performs well on many economic and social outcome indicators, but often poorly on environmental performance (Table 1.1).

1.4 The link between productivity, innovation and intangible capital

Typically, high commitment to, and investment in, innovation is found in relatively productive firms. Investment in R&D, or new machinery and equipment is an important input into innovation, but only gives only a partial picture of innovation investment. This is particularly the case with service-oriented businesses.[30] They invest in a wider range of non-physical or intangible capital.

Intangible capital includes assets such as data, software, designs, new organisational processes, management quality, R&D, patented technology, reputation (brand equity) and firm-specific skills.

Investment in intangible capital is an important source of international competitiveness. Intangible capital typically generates the highest value

28 Lydon J et al. (2014) *Compete to prosper: improving Australia's global competitiveness*, McKinsey Australia.

29 Grossman G M & Helpman E (1994) Endogenous innovation in the theory of growth, *Journal of Economic Perspectives* 8(1):23–44; Wakelin K (1998) Innovation and export behaviour at firm level, *Research Policy* 26:829–41; Roper S & Love JH (2002) Innovation and export performance: evidence from the UK and German manufacturing plants, Research Policy 31(7):1087–1102; Cassiman B & Golovko E (2007) *Innovation and the export-productivity link*, CEPR Discussion Papers 6411, CEPR, London; Damijan J P et al. (2010) From innovation to exporting or vice versa, *The World Economy* 33(3):374–98; Palangkaraya A (2013) *On the relationship between innovation and export: the case of Australian SMEs*, Intellectual Property Research Institute of Australia Working Paper 3/13.

30 Haskell J & Westlake S (2014) Look to the intangibles, free exchange economics blog, *The Economist*, 20 February 2014, www.economist.com/blogs/freeexchange/2014/02/investment.

in a supply chain.[31] Recent OECD research demonstrates the growing importance of intangible capital investment as a source of productivity growth at the macroeconomic level.[32] Intangible assets can add unique quality to goods and services, and make better use of labour, materials, energy and physical capital assets to deliver greater outputs per unit input.[33]

Today, investors and traders focus much more on businesses' intangible assets for insight into long-term performance and competitiveness. According to the OECD, the market value of a firm increases with its investment in intangible assets,[34] as does its profitability.[35] Since 1975, the market value of S&P 500 companies[36] has deviated greatly from their book value (physical and financially accountable assets reflected on a company's balance sheet), so that now this book value comprises less than 20% of the market value of the average S&P 500 firm.[37]

Australian research shows that high-performing businesses have significantly higher investment in intangible assets, and average profit margin ratios that are three times higher than low-performing businesses, a difference of $40,051 per full-time employee.[38] Investment in intangibles doesn't just affect the investor. Research on US businesses found that R&D investment of one firm raised not only the stock price of that firm, but also the stock price of other firms in the same industry.[39]

Intangible capital investment by business accounts for between 12% and 20% of Australia's average labour productivity growth, depending on the economic cycle being examined.[40] In the European Union and US, where intangible capital investment is often a much higher share of the Gross

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31 OECD (2013) *Interconnected economies: benefiting from global value chains*, synthesis report, OECD Publishing, p. 34.

32 Andrews D & de Serres A (2012) Intangible assets, resource allocation and growth: a framework for analysis, *OECD Economics Department Working Papers* 989, OECD Publishing.

33 Cummins J (2005) A new approach to the valuation of intangible capital, in: Corrado C et al. (eds), *Measuring capital in the new economy: studies in income and wealth*, vol. 65, National Bureau of Economic Research, Chicago, pp. 47–72.

34 OECD (2013) *Supporting investment in knowledge capital, growth and innovation*, OECD Publishing.

35 A comparison of the market value of a company with its book value demonstrates that the market value of a firm increases with its investment in intangible assets.

36 S&P 500 (Standard & Poor's 500) is a stock market index based on the market capitalisations of 500 very large companies having common stock listed on the New York Stock Exchange or NASDAQ. It is one of the most commonly followed equity indexes, and many consider it one of the best bellwethers for the US stock market and economy.

37 Ocean Tomo (2010) *Ocean Tomo's annual study of intangible asset market value—2010*, www.oceantomo.com/media/newsreleases/intangible_asset_market_value-2010.

38 Boedker C et al. (2011) *Leadership, culture and management practices of high performing workplaces in Australia: the high performing workplaces index*, Society of Knowledge Economics, Sydney.

39 Bloom N et al. (2013) *Identifying technology spill overs and product market rivalry*, NBER working paper 13060.

40 Barnes P & McClure A (2009) *Investments in intangible assets and Australia's productivity growth,* Productivity Commission, staff working paper, Canberra; see also the Australian Innovation System Reports 2011 and 2012, www.industry.gov.au/aisreport.

Domestic Product (GDP), intangible capital investment contributes 20–34% of average labour productivity growth.[41]

GDP per capita can be lifted by increasing workforce participation, increasing the number of hours we work (labour utilisation) or by improving the efficiency with which we work (labour productivity).[42] But Australia's working population is projected to shrink in the next 50 years.[43] There is also a limit to how much that population can:

1. participate in the workforce
2. once participating, work longer hours
3. keep moving where the work is.[44]

Therefore, sustained growth in material living standards will need to come from productivity increases in the long term.[45]

Ultimately, even though we're a technology business, the sales process and selling something like this is not about technology. It's about how can we improve your communications, and asking what we can do for you. When you start like that and then you win their trust, then you sell the tech.

—Ian Gardiner, Viocorp

1.5 What is competitiveness?

This year's report focuses on the competitiveness of Australian businesses, in particular, the role innovation plays to support competitiveness at the firm, sectoral and national level. The General Electric (GE) Global Innovation Barometer surveyed senior executives, and 92% agreed that innovation is the main lever to create a more competitive economy.[46] In Australia, 91% of firms surveyed reported a benefit from innovation including gaining a competitive advantage.[47]

As part of the Australian Government's new Industry, Innovation and Competitiveness Agenda, Prime Minister Tony Abbott said that 'improving Australia's competitiveness is essential in building the stronger economy that we all want'.[48]

There are many definitions of competitiveness in the literature. For the purposes of this report we use the following definitions.

The **competitiveness** of trade-exposed firms is defined as their ability to succeed in international competition against leading international competitors. For firms that are non-trade exposed, competitiveness is

41 OECD (2013) *Supporting investment in knowledge capital, growth and innovation*, OECD Publishing.

42 GDP/capita = hours/capita (labour utilisation) × GDP/hour (productivity).

43 Australian Treasury (2011) *Australia to 2050: future challenges*. Intergenerational report 2010, Canberra.

44 Australian Treasury (2011) op. cit.; and Hugo G et al. (2010) Report of the Advisory Panel on Demographic Change and Liveability, p. 61.

45 Australian Treasury (2011) *Australia to 2050: future challenges. Intergenerational report 2010*, Canberra.

46 GE (2012) *Global Innovation Barometer: Australia, 2012 report*, GE Australia & New Zealand, Melbourne.

47 ABS (2012) Innovation in Australian business, 2010–11, cat. no. 8158.0, ABS, Canberra.

48 www.pm.gov.au/media/2014-10-14/action-plan-australias-future.

defined by their ability to be as efficient and effective as global leaders in their industry.[49]

At a **national level**, competitiveness can refer to framework conditions (the mix of business conditions, culture and government policy) that fosters healthy competition, encourages innovation, and maintains external price and cost competitiveness in firms and sectors.

Taken together, these different dimensions of competitiveness should sustain real income growth, and other less-tangible social and environmental measures of national welfare.

These definitions explicitly recognise the importance of both domestic and trade-exposed sectors of the economy. In this report, we focus on innovation at the firm level to show the strong association between innovation and competitiveness. We then focus on innovation, productivity and trade data at the sectoral and national level to determine Australia's competitiveness.

In a globalised economy, where Australian markets are increasingly exposed to competition from rival foreign businesses, exports and export growth is a partial indicator of international competitiveness,[50] proof that a country's businesses can survive, and even thrive, in the global marketplace. The same criteria apply for the competitiveness of import-competing businesses, where producers grow or maintain sales and market share against rival imports. By exporting, Australia generates income to buy goods and services that other countries produce or are better at producing. This leaves Australia to focus on the goods and services where it can be most productive. Through this exchange, Australia's standard of living improves.

Evidence shows that exports contribute greatly to the wealth of a nation. During the past 20 years, Australia's compounded average annual GDP growth has been 3.3%, almost a third (0.9%) of which can be attributed to exports.[51] Econometric evidence also points to a positive causal link between levels of productivity and exporting for developed countries.[52] Between 1990 and 2007, based on US Bureau of Labour data, internationally exposed corporations in the US increased their labour

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49 Based on Enright MJ & Petty R (2013) A*ustralia's competitiveness: from lucky country to competitive country*, CPA, Wiley & Sons, Singapore.

50 There are a lack of Australian data linking import activity and import competition with innovation activity. References to international competitiveness relate to export activity as it relates to innovation. International evidence suggests that import competition, at least between developed countries, has no effect on innovation. See Bloom N, Draca M & Van Reenen J (2012) *Trade-induced technological change? The impact of Chinese imports on innovation, diffusion of IT and productivity*, National Bureau of Economic Research working paper 16717.

51 Data source: ABS (2014) *Australian National Accounts: national income, expenditure and product*, Table 32. Expenditure on gross domestic product (GDP), chain volume measures and current prices, annual, cat. no. 5206.0, (calculations Department of Industry), ABS, Canberra.

52 Marin D (1992) Is the export-led growth hypothesis valid for industrialized countries? *The Review of Economics and Statistics* 74(4):678–88; and Kónya L (2004) Export-led growth, growth driven export, both or none? Granger causality analysis on OECD countries, *Applied Econometrics and International Development* 4(1):73–94.

productivity at more than twice the rate of other private-sector firms.[53] By tapping into the global innovation system, Australia is free to specialise its exports in areas where we have a distinct innovation advantage.[54] The greater the diversity of highly innovative, productive sectors in the economy, the more resilient it is to global structural shifts. The export diversity (or complexity) of an economy can be a strong predictor of its national income. According to a McKinsey & Co. report, economies with more global connections in terms of flows of goods, services and finance see up to 40% more GDP growth than less-connected economies.[55] For this reason, several chapters of this report use export data and their relationship to innovation as evidence of international competitiveness of our trade-exposed industries.

However, it is important to remember that exports accounted for only 20% of Australia's GDP in 2012–13.[56] The service sector, which largely has a domestic focus, accounts for a much larger proportion (68% in 2012–13) of GDP. Promoting competitiveness of both exporting and non-exporting businesses are important policy issues.

1.6 Trade, competitiveness and learning

Trade provides an excellent opportunity for business learning.[57] This learning and knowledge leads to new or improved products and processes that raise productivity-driven[58] competitiveness.

Of the world's total research knowledge, 97% is created outside of Australia (see Chapter 8). For Australia to benefit from the global pool of knowledge and resources, it must exchange knowledge and innovations through trade, international collaboration and other means. Trade helps the production and diffusion of innovation be more effective and also helps more productive firms to expand into larger markets, thereby taking advantage of economies of scale.

Trade affects learning in three different ways:

- **Learning by doing.** Trade will encourage specialisation and increasing economies of scale, and this will improve the opportunities for learning. For countries with high human capital and a skilled workforce like Australia, trade should promote the switch to activities

53 McKinsey & Company (2010) *Creating economic growth In Denmark through competition*, pp. 61–2, www.stm.dk/multimedia/Creating_Economic_Growth_in_Denmark_Through_Competition.pdf.

54 Lydon J et al. (2014) *Compete to prosper: improving Australia's global competitiveness*, McKinsey Australia.

55 McKinsey & Company (2014) *Global flows in a digital age*, pp. 6, 22, 150. www.mckinsey.com/insights/globalization/global_flows_in_a_digital_age

56 ABS (2014) *Australian National Accounts: national income, expenditure and product*, Table 32, cat. no. 5206.0.

57 Love P & Lattimore R (2009) *International trade: free, fair, open,* OECD Insights, OECD Publishing.

58 Productivity in this sense is both less input per the same output (cost advantage) as well as more output for the same inputs (value advantage).

that have high knowledge content and, hence, higher spill overs and learning opportunities.

- **Learning by exporting.** Exporting firms will learn from foreign clients and customers. They will also learn from competitors that may use more advanced technologies, production and management methods. Foreign markets may be more sophisticated than domestic markets, and more advanced standards and regulations may force firms to innovate.
- **Learning by importing.** Having access to imported intermediary goods incorporating the latest technology give domestic firms the opportunity of learning by imitation, reengineering or just incorporating these products into their production process. Imports also promote competition. Local firms will also to learn to be more efficient and innovative to maintain or grow their market share.

1.7 Measuring competitiveness at the national level

There are a number of indexes and reports that assess and measure the conditions for competitiveness on an internationally comparable basis. Many of these indexes use opinion-based surveys to complement more robust data sources. This can often introduce significant volatility and subjectivity in country rankings and so many of these indexes should be interpreted with caution. These international indexes rank Australia around 20th overall on competitiveness. Most of these measures show that, despite getting the framework conditions right, Australia's global competitiveness ranking is often weaker than other advanced countries and is slipping. Additionally, many of these indexes give specific prominence to innovation and knowledge creation.

As argued, national competitiveness depends on our ability to create framework conditions that set the right environment for competitive firms, both in the domestic and international markets. The Heritage Foundation, in partnership with the Wall Street Journal, have developed the Index of Economic Freedom,[59] which measures the economic freedom of 186 countries based on trade freedom, business freedom, investment freedom and property rights. Australia ranked 3rd out of 186 countries, only behind Hong Kong and Singapore (Table 1.1). Australian ranked particularly well in property rights protection, business freedom, investment freedom and financial freedom.

The World Economic Forum's 2014–15 Global Competitiveness Report ranks Australia 22nd (down from 21st) for overall competitiveness among 144 countries (Table 1.1).[60] This continues a gradual decline since 2001, which is partially due to the improvement of other countries. Australian

59 The Heritage Foundation (2014) *2014 Index of Economic Freedom*, www.heritage.org/index

60 World Economic Forum (2014), *The Global Competitiveness Report 2014–15*, www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2014-15.pdf.

scores (not rankings) have remained stable. Australia scores higher in areas such as financial market development, higher education and training, and technological readiness. In areas like innovation and business sophistication, Australia does not perform as well as other advanced economies.[61] Australia lost ground on labour market efficiency, down from 54th to 56th in 2013. Australia's slippage in this area has been more dramatic given that in 2008 Australia ranked 9th. A closer look at the components of labour market efficiency indicates that the main cause of this slip in ranking has been the result of the executive opinion survey. For example, in the labour market efficiency component 'pay and productivity', Australia slipped from a peak of 26th in 2008 to the 125th position in 2014.[62]

The World Competitiveness Yearbook,[63] produced by the International Institute of Management Development (IMD), ranked Australia 17th of 60 countries in its Competitive Scoreboard 2014, down one place compared to 2013 (Table 1.1). According to the IMD scoreboard, Australia's overall competitiveness has fallen quite dramatically since 2010 when it ranked 5th. The Committee for Economic Development of Australia attributed this decline in ranking to skills shortages, labour market disputes and the high Australian dollar.[64] On the innovation landscape, Australia ranked low in technological infrastructure (29th), but higher in science infrastructure (18th) and education (10th).

The Global Innovation Index, published jointly by Cornell University, INSEAD business school and the World Intellectual Property Organization, focuses on factors affecting innovation outcomes. In this index, Australia ranked 17th out of 143 countries, up from 20th in 2013. Australia ranks 10th for innovation inputs and 22nd for innovation outputs, which suggests poor innovation system efficiency relative to other innovation-driven countries. This report also rates Australia favourably on institutions, human capital, research inputs, infrastructure and market sophistication, but less well on business sophistication, technology outputs, and the proportion of science and engineering graduates.[65] Recent analysis of Australian trends and current performance on the Global Innovation Index shows that the innovation system is falling behind and poorly ranked on networking, knowledge absorption education and ecological sustainability.[66]

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61 World Economic Forum (2014), *The Global Competitiveness Report* 2014–15, www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2014-15.pdf.

62 However, wage growth has been at its lowest level since the ABS Wage Price Index (ABS cat. no. 6345.0) series was established in 1997, well below the inflation rate. Labour productivity has risen in the past three years (ABS cat. no. 5204.0), likely due to movement of workers from low-productivity to high-productivity industries (see Borland J (2014) theconversation.com/labour-productivity-has-risen-but-its-not-exactly-a-good-news-story-28901).

63 IMD World Competitiveness Center (2014) *World Competitiveness Yearbook*, www.imd.org/wcc/wcy-world-competitiveness-yearbook.

64 Committee for Economic Development of Australia, www.ceda.com.au/research-and-policy/explore-all-ceda-research/surveys/world-competitiveness-yearbook

65 Cornell University, INSEAD & WIPO (2014) *The Global Innovation Index 2014: the human factor in innovation*, Fontainebleau, Ithaca and Geneva, p. 145, www.globalinnovationindex.org/content.aspx?page=gii-full-report-2014#pdfopener

66 Deloitte Access Economics and Business Council of Australia (2014) *Australia's innovation imperative*, pp. 14–15.

The Australian Competitiveness Survey, produced by Professors Michael Enright and Richard Petty, and CPA Australia, provides interesting insights on Australian competitiveness based on the views of both Australian and international business leaders. It assesses competitiveness at the sectoral and national level. This is important in the context of this report, which looks at sectoral differences in export performance and innovative capacity. The Australian Competitiveness Survey shows that, for most sectors of the Australian economy, Australian businesses rate costs quite highly as a driver for competitiveness.[67] However, other countries see Australia differently. Businesses from other countries rated costs as one of the lowest drivers of Australia's competitiveness. Instead, other countries see skills, research and technology endowments as most important. See Box 1.3 for more details on these results.

Cost structures that firms face when seeking to compete both internationally and domestically are an important factor for competitiveness. According to a recent report by the Boston Consulting Group,[68] there have been rapid changes in cost competitiveness across the world during the past decade and these changes have not been favourable to Australia in manufacturing. In fact, according to the report, among the world's 25 largest goods-exporting countries, Australia has the highest manufacturing cost base in terms of manufacturing wages, productivity, energy costs, currency exchange rates and other factors. Australia's manufacturing cost competitiveness has also deteriorated significantly according to this index since 2004 relative to the US and other top exporting countries. Decreasing cost competitiveness in Australia means that it will need to be compensated by other factors, such as innovation, efficiency-based advances in productivity and improved resource allocation.

Box 1.3 Feature: Australia—the knowledge-innovation economy and competitiveness

By Professor Michael J Enright and Professor Richard Petty

67 Enright MJ & Petty R (2013) *Australia's competitiveness: from lucky country to competitive country*, CPA, Wiley & Sons, Singapore.

68 Sirkin HL et al. (2014) *The shifting economics of global manufacturing: how cost competitiveness is changing worldwide*, Boston Consulting Group, www.bcgperspectives.com/content/articles/lean_manufacturing_globalization_shifting_economics_global_manufacturing

Developed economies increasingly rely on knowledge and innovation to enhance their prosperity and competitiveness. Some people equate the knowledge-innovation economy with 'high-technology' industries or to specific activities like research and development (R&D). However, the knowledge-innovation economy also involves innovation in business systems, business processes, standards, training and market development, and encompasses knowledge-intensive professional services, creative industries and managerial activities. Knowledge and innovation can be competitive weapons in any industry and, although R&D activities may be knowledge-intensive, they are not the only knowledge-intensive activities that firms perform, nor are they necessarily the most important.

A competitive knowledge-innovation economy is enabled by:

- a highly developed education system
- a talented workforce with qualified managers and professionals
- the presence of research institutes, universities and think tanks
- high levels of information and communications technology
- opportunities to commercialise innovations and leverage knowledge capabilities
- technology adoption
- cultural diversity
- networking and collaboration among knowledge workers and across industries.

In addition, a knowledge-innovation economy cannot succeed unless it is sufficiently connected with sources of information, markets, and sources of supply inside and outside the country.

There are several ways of measuring a nation's position in the knowledge-innovation economy, as evidenced by this and previous Australian Innovation System Reports. These measures are informative, but often lack the granularity needed to develop clear priorities. The reason is, although Australia might be ahead or behind in a particular measure, the usual sources do not tell us how important the related features are in industries that matter for Australia. To provide such a picture, we carried out a comprehensive survey, in conjunction with CPA Australia that elicited responses from more than 7000 respondents across all of Australia's major industries. In this survey, we asked three main sets of questions:

- who are the relevant competitors for Australia in the respondent's industry
- how important are individual drivers to competitiveness in that industry
- how does Australia measure up against the main competitors in the individual drivers for that industry.

The survey was part of a much larger project on Australia's competitiveness, which was described in our book Australia's competitiveness: *From lucky country to competitive country.*[69]

The survey, carried out in 2012, assessed the importance and Australia's performance across 76 drivers of competitiveness for all major Australian industries. Tables A.1–A.4 in Appendix A show the results for 25 of the drivers

69 Enright MJ and Petty R (2013) *Australia's competitiveness: from lucky country to competitive country*, CPA, Wiley & Sons, Singapore, as.wiley.com/WileyCDA/WileyTitle/productCd-1118497368.html.

of competitiveness related to innovation, according to major industry groups as classified by the Australian and New Zealand Standard Industrial Classification.

Importance of competitiveness drivers: primary and manufacturing sectors

Table A.1 shows that the importance of different competitiveness drivers varies greatly by industry within the primary and manufacturing sectors.[70] When the results are averaged across these sectors, all of the features were viewed as important (above neutral 4). The most important competitive drivers of all those listed were:

- staff costs
- access to appropriate staff skills
- overall government policy
- level of technology employed
- quality of education and training institutions.

The least important competitiveness drivers of those listed were:

- tough local competition
- access to debt finance
- availability of venture capital
- cooperation among local firms
- clustering of firms in your industry.

Australia's performance versus relevant competitiveness: primary and manufacturing sectors

Table A.2 shows that Australia's perceived performance in different competitiveness drivers also varies by industry. When the results are averaged across the primary and manufacturing industries, Australia was seen as having at least slight advantages in all of the drivers listed (above neutral 4) except staff costs.

The drivers in which Australia performed the best versus main competitors among drivers listed were:

- quality of life
- quality of education and training institutions
- level of technology employed
- access to business relevant information
- quality of research institutions and organisations.

The drivers that performed the worst were:

- policies to encourage R&D
- tough local competitions
- clustering of firms in your industry
- overall government policy
- staff costs.

Importance of competitiveness drivers: utilities, construction and service sectors

Table A.3 shows that respondents in the construction, utilities and service sectors,

70 The differences are even greater when we disaggregate the data further.

on average, viewed all of the features as important (above neutral 4). The most important of the drivers of competitiveness of those listed were:

- access to appropriate staff skills
- information technology and internet infrastructure
- staff costs
- communication infrastructure
- quality of life.

The least important of the drivers of competitiveness of those listed were:

- availability of venture capital
- knowledge of Asian markets
- science and technology policy
- access to debt finance
- clustering of firms in your industry.

Australia's performance versus relevant competitiveness: utilities, construction and service sectors

Table A.4 shows that respondents in the construction, utilities and service sectors, on average, viewed Australia as having at least a slight advantage in all of the drivers listed (above neutral 4) except for staff costs. The drivers in which Australia performed the best versus main competitors among drivers listed were:

- quality of life
- access to local managerial skills
- quality of education and training institutions
- access to appropriate staff skills
- scientific and technical skills.

The least important of the drivers of competitiveness of those listed were:

- science and technology policy
- clustering of firms in your industry
- policies to encourage R&D
- overall government policy
- staff costs.

What the results mean for Australia

Our approach allows for a clear prioritisation of efforts. Drivers of innovation and competitiveness that are important and in which Australia has advantages should be extended, marketed and exploited. Drivers that are important and in which Australia has disadvantages should be overcome, mitigated or potentially innovated out of the game. Drivers that are unimportant and in which Australia has advantages should be investigated to determine whether their importance can be increased. Drivers that are unimportant and in which Australia has disadvantages can be ignored until efforts on other drivers have taken place.

Although averages across industries are interesting, it is the ability to understand how to improve competitiveness and innovative performance on an industry-by-industry basis that is the most valuable feature of this approach. Hopefully, this approach can be a useful supplement to the existing work on innovation systems and competitiveness in Australia.

1.8 Structure of this report

Chapter 2 examines the evidence linking business innovation with business and macroeconomic performance. Innovation, particularly new-to-market innovation, is highly correlated with productivity and exporting activity. However, Australian exporters have poor new-to-market innovation performance compared with other countries. The chapter also assesses Australia's labour productivity, investment in intangible capital, entrepreneurship, management and business innovation performance across a range of measures. It also examines the main barriers to innovation in Australia.

Chapter 3 investigates Australia's export performance and competitiveness in terms of where our comparative advantages lie. It also assesses the complexity of Australia's export profile and our level of international engagement.

Chapter 4 examines the global value-added trade associated with the fragmentation of production processes, the suppliers of Australia's exporters and Australia's participation in global supply chains.

Chapter 5 assesses Australia's collaboration performance and the absorptive capacity of our firms as a fundamental aspect of our national innovation system.

The remaining chapters examine various framework conditions of the innovation system. Chapter 6 hones in on some key framework conditions that facilitate innovation, including openness to trade, e-commerce, foreign investment and the role of foreign-owned firms in the transmission of innovation and export activity. Subsequent chapters focus specifically on skills and migration (Chapter 7) and research capabilities (Chapter 8) as framework conditions necessary for innovation and competitiveness to thrive.

Due to the length and complexity of many of the tables in this document, they are placed at the end of each chapter rather than where they are mentioned in the text.

1.9 A note on data collection methodologies and limitations

Where possible, this report's concepts, definitions and methodology are based on the Innovation Metrics Framework Report and the concept of an innovation system introduced in previous reports.[71] Data in this report are current as of September 2014.

71 For further discussion, see *Australian Innovation System Report 2011*, Canberra, pp. 11–13.

As part of a systems approach to measuring innovation, international comparisons for each indicator are presented where possible.[72] Country comparisons are made because policy mixes can be quite different. Country comparisons help us think about which activities work best in different frameworks, and how networks and cultures affect innovation.

Unlike Australia, many other OECD countries' national survey instruments for measuring business innovation are not mandatory, leading to variable coverage and low response rates. These differences may have the effect of skewing other country data towards the most innovative businesses that are motivated to report their innovative activities. In addition, most OECD countries collect three-year aggregates of business activity, whereas Australia reports annually. The likely consequence is that Australia's innovation performance will appear lower compared with other OECD countries. Analysis by the Australian Bureau of Statistics (ABS) suggests this is not a significant effect;[73] however, we believe that this requires more evidence. Other measures of education and R&D investment are more comparable.

A challenge in describing the innovation system is the timeliness and quality of quantitative data. Many organisations that we rely on release their data between 18 months and three years after they were collected. So this report, although released in 2014, typically paints a picture of where we were at two to five years ago. For this reason, it is important to capture more qualitative information on innovation through case studies and feature articles by experts on innovation and entrepreneurship.

The report contains robust indicators produced by the ABS that are often internationally comparable, particularly the Business Characteristics Survey (BCS). This report also includes a range of less rigorous business opinion survey information in support of official data, notably in the Global Competitiveness Index. This survey information helps to give a more current snapshot of business conditions or sentiment, but can feature very limited numbers of survey participants. For this reason, the data should be considered complementary and interpreted with caution.

This report uses a variety of indicators drawn from different datasets, each of which uses its own methodologies. It is important to recognise that each indicator used has its own methodological limitations. It is not possible to provide complete analysis of the pros and cons of each methodology within this report. It is therefore recommended that the reader refer to the source for metadata and more comprehensive discussion of methodology.

Where possible, all table indicators are provided back to 1995. Most Australian innovation data are compiled according to fiscal years, whereas OECD data are compiled according to calendar years.

72 OECD (2009) *Innovation in firms: a microeconomic perspective*, OECD Publishing.

73 Unpublished analysis by the ABS.

This report includes a number of indicators related to export activity. These indicators use the nation as a comparative entity. Where possible, indicators are normalised to the size of the economy (GDP). It is difficult to take into account other aspects that affect export activity, such as geographical position or the presence of a common market, such as the EU common market or the North American Free Trade Agreement between the US, Canada and Mexico.

This report uses the concept of revealed comparative advantage (RCA) as a proxy for specialisation and export-related competitiveness of industry sectors at different levels of industrial disaggregation. This index is discussed together with absolute values of exports in dollar terms to give context to the sectoral values of RCAs.

When discussing innovation and competitiveness, we undertake analysis at three levels of disaggregation—the country level, the sectoral level and the firm level. We use firm-level analysis of qualitative and quantitative data to establish the strength of the association between innovation and business performance measures, such as productivity. We use sectoral- and national-level comparisons to establish Australia's relative performance on innovation. We use a range of indicators to provide a more comprehensive picture that what might be understood from a simple international ranking. A seemingly positive international comparison can—with some deeper digging into sectoral or related data—be revealed to be not as positive, or at least more complex, than previously thought. International rankings on innovation for manufacturing suggest that Australia has a relatively high degree of innovation. This high ranking does not necessarily translate into a high degree of international competitiveness, as being innovative can represent a relatively low threshold. A low percentage of Australian businesses have implemented new-to-world innovation, and this type of innovation seems to be correlated with exporting activity, particularly for small to medium enterprises.

1.10 The Business Characteristics Survey

The series of Australian Innovation System Reports heavily use the Business Characteristics Survey (BCS), an annual survey administered by the ABS.[74] The BCS is financially supported each year by the Australian Government Department of Industry (the department). The department and the ABS work together on the ongoing development and improvement of the BCS.

The BCS is the vehicle for the ABS's Integrated Business Characteristics Strategy, which is designed to integrate the collection and quality assurance of data required for input into the ABS's Business Longitudinal Database. It also produces point-in-time estimates for use of information technology, innovation and a broad range of other non-financial characteristics.

74 Australian Bureau of Statistics (2014) Innovation in Australian business, 2013–14, catalogue no. 8158.0, ABS, Canberra, www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/8158.0Explanatory%20Notes12013–14?OpenDocument.

Businesses surveyed for the BCS are sourced from the Australian Business Register, administered by the Australian Taxation Office. Approximately 6500 businesses are randomly sampled using a mail-out questionnaire. The sample is stratified by industry and an employment-based size indicator. All businesses on the Australian Business Register identified as having 300 or more employees are included in the sample. The ABS then uses the sample to estimate the activity of the entire employing business population.

A key part of the BCS is a detailed set of questions on business innovation asked every second year. This is why some business innovation data presented in this report are only available every second year. The detailed survey includes questions on drivers, sources of ideas and collaboration for innovation.

These detailed questions on innovation, and the broader BCS questions on markets and business performance, have allowed the department to undertake detailed analysis of the impact and nature of innovation in Australia, as well as construct novel customised innovation indicators. For example, by cross-tabulating survey questions on business financial indicators with innovation questions, we get, for example, Figure 2.1 in Chapter 2. Any chart in this report that cites ABS customised data are an example of this collaboration.

The BCS uses the OECD definition of innovation (described in Section 1.1), which enables Australia to contribute to OECD country comparisons on innovation. Many of these country comparisons on innovation are used in Chapters 5 and 7.

The BCS covers four broad types of innovation (goods or services, operational processes, organisational/managerial processes and marketing methods) across three innovation statuses (introduced, still in development and abandoned). These are combined to group businesses into two categories of innovation: innovating businesses (which includes businesses that introduced at least one type of innovation during the reference period) and innovation-active businesses (which includes businesses that undertook any innovative activity irrespective of whether the innovation was introduced, still in development or abandoned).

The percentage of innovation-active businesses in Australia is the key measure of ‘innovativeness’ of the business sector. The latest proportion of innovation-active businesses (i.e. those that undertook any innovative activity) in 2012–13 was 42% (See Chapter 5 for more detail).

Despite of being a very useful for the analysis of innovation there are some caveats to the BCS data. Firstly, the sample size is limited and this affects the quality the quality of data at the Australian and New Zealand Standard Industrial Classification subdivision level, and sometimes even at the division level of industry disaggregation. Secondly, the data are based on businesses self-assessing their innovation activities, including expenditure. Finally, the survey measures the incidence of innovation (a YES/NO question) as opposed to innovation intensity or frequency (i.e. how often or how much did

you innovate). We cannot currently identify how often a business undertook innovation in any given year.

Table 1.1 Outcome indicators

Australian Trend Data (i)												OECD Comparisons				
Indicators	1995	2000	2005	2007	2008	2009	2010	2011	2012	2013	2014	Australia's score (ii)	OECD average (iii)	OECD top 5 average (iv)	Gap from the top 5 OECD performers (%) (v)	Ranking against OECD countries (vi)
GDP per capita relative to the US (US = 100), index[1]	78	77	79	81	81	87	86	87	86	86	–	86	71	117	27	5
Index of Economic Freedom, score[2]	74	77	79	81	82	83	83	83	83	83	82	82	71	81	no gap	1
Resilience of the economy, score[3] (a)	–	–	8	6	7	6	7	8	7	7	7	7	5	7	5	6
Index of Economic Complexity[4] (b)	–0.02	0.16	–	–	–	–	–0.21	–	–	–	–	–0.21	1.18	1.89	111	32
Hannah–Kay index of industrial specialisation[5]	–	–	–	–	–	0.55	–	–	–	–	–	0.55	0.56	0.67	17	20
Global Competitiveness Index, 1–7 (best), score[6] (c)	–	–	5.2	5.2	5.2	5.2	5.1	5.1	5.1	5.1	–	5.1	4.9	5.5	8	15
Global Innovation Index[7]	–	–	–	–	–	–	–	49.9	51.9	53.1	55.0	55.0	52.0	62.1	11	15
GDP/hour worked (US = 100), index[1]	82	84	81	81	80	82	80	81	83	83	–	83	71	110	24	12
Production-based CO_2 productivity, $US/kg CO_2,[8]	1.68	1.73	1.82	1.89	1.92	1.91	2.00	2.05	–	–	–	2.05	3.85	6.6	69	33
Energy productivity, US$/kilotonne oil equivalent,[6 8]	5.19	5.42	6.06	6.22	6.13	6.13	6.34	6.75	–	–	–	6.75	7.74	10.96	38	22
Non-energy material productivity, US$/kg,[8]	0.82	0.86	0.97	1.02	0.94	0.89	1.09	1.11	–	–	–	1.09	2.57	5.03	78	30
Water productivity, total (constant 2000 US$ GDP/cubic meter of total freshwater withdrawal), US$[9](d)	23.4	27.7	–	32.8	–	–	–	36.1	–	–	–	36.1	98.7	339.1	89	23
Human Development Index[10] (e)	0.87	0.90	0.91	–	0.92	–	0.93	0.93	0.93	0.93	–	0.93	0.87	0.92	no gap	2
Environmental Performance, Index[11] (f)	–	81	81	82	82	82	82	82	82			82	74	83	no gap	3

– = *data not available*

Table notes: (i) Data are presented in calendar year format. Where the data are in financial years, it is expressed in terms of the year where the financial year begins e.g. 2010–11 is shown as 2010. (ii) The 'Australia's score' field presents the Australian values used in the OECD comparisons. (iii) This is the arithmetic (simple) average of the OECD country scores. (iv) This is the arithmetic (simple) average of the top five OECD countries in a ranked list. (v) This represents Australia's distance from the frontier as defined by the average of the top five ranked OECD countries. It is calculated as 100*(Top five average - Australia's score)/ Top 5 average. Where the solution is a negative value or zero, 'no gap' is shown in the cell. (vi) OECD rankings are performed on those OECD countries for which data are available. Individual data availability may vary between indicators.

Indicator notes: (a) For this indicator, survey respondents were asked to answer the question 'Resilience of the economy to economic cycles' scores refer to a (weak) 0 – 10 (strong) scale. (b) From hard copy book. Online version differs. (c) 2006 data are used in the absence of 2005 dat4a. (d) 1997 data used in absence of 1995 data; 2002 data used in absence of 2000 data. (e) See Technical note 1 (http://hdr.undp.org/en) for details on how the HDI is calculated 1990 data are used in the absence of 1995 data. (f) 2002 data used in absence of 2000 data.

Sources: [1] OECD (2014) GDP per capita and productivity levels, OECD Productivity Statistics (database). May 2014. Accessed 2014-07-02 DOI: 10.1787/data-00686-en. [2] The Heritage Foundation (2014) Index of Economic Freedom. 2014. Accessed 2014-07-04 URL: http://www.heritage.org/index. [3] IMD (2014) World Competitiveness Online. May2014. Accessed 2014-07-04 URL: https://www.worldcompetitiveness.com. [4] Center for International Development at Harvard University (2014) Atlas of Economic Complexity. 2014 book. Accessed 2014-09-08 URL: http://atlas.cid.harvard.edu/book. [5] OECD (2014) Structural Analysis (STAN). 2014. Accessed 2014-09-05 URL: http://stats.oecd.org/Index.aspx?DataSetCode=STAN08BIS. [6] World Economic Forum (2013 - 2014) Global Competitiveness Index. 2014-15. Accessed 2014-09-12 URL: http://www.weforum.org/issues/global-competitiveness. [7] Cornell University, INSEAD, WIPO (2013) Global Innovation Index. GII2013. Accessed 2014-03-05 URL: http://www.globalinnovationindex.org [8] OECD (2014) Green growth indicators. 2014. Accessed 2014-07-02 DOI: 10.1787/data-00686-en. [9] World Bank (2014) World Development Indicators. 2014. Accessed 2014-07-01 URL: http://data.worldbank.org/data-catalog/world-development-indicators. [10] United Nations Development Programme (2014) Human Development Index. 2014 Table 2: Human Development Index trends, 1980-2013. Accessed 2014-09-05 URL: http://hdr.undp.org/en/content/human-development-index-hdi. [11] Yale University and Columbia University (2014) Environmental Performance Index. Accessed 2014-07-01 URL: http://epi.yale.edu.

2. Innovation and competitiveness

This chapter examines the evidence linking business innovation with business and macroeconomic performance, and find that innovators comprise less than half of all firms but account for more than 70% of national income and employment. Innovation, particularly world-first innovation, is highly correlated with productivity and exporting. However, Australian exporters have poor world-first innovation performance compared with other countries.

Australia's business innovation investments are growing but still low by Organisation for Economic Co-operation and Development (OECD) standards. Australia's rate of entrepreneurship remains high by OECD standards despite a recent decline. Australian small and medium-sized enterprises (SMEs) perform relatively well and large firms relatively poorly in innovation by OECD standards. The firms that are innovating predominantly do so by adopting and modifying others' innovations rather than delivering new-to-market innovations. Australia has one of the lowest proportions of innovators that are active in research and development (R&D) in the OECD and the lowest level of public support for innovation across all firm sizes and sectors. A range of systemic innovation issues, including management capability, if addressed, could significantly boost Australia's competitiveness.

2.1 The contribution of innovation to the Australian economy

Chapter 1 explained that innovation is a tool for creating and capturing value for a business and its customers, translating into increased productivity and profitability. This gives businesses a competitive advantage in the market that, when aggregated, drives sectoral and national competitiveness, and the productive re-allocation of resources throughout the economy. The impact of this innovation-driven allocative efficiency in the Australian economy is suggested in Figure 2.1. Despite representing less than half of all employing businesses in the economy in 2011–12, innovative businesses accounted for around 70% of total employment, total capital expenditure and total business income, and more than 80% of total internet

Innovation is a core part of the DNA. If we weren't innovative we wouldn't be around. It is as simple as that.

—Ian Gardiner, Viocorp

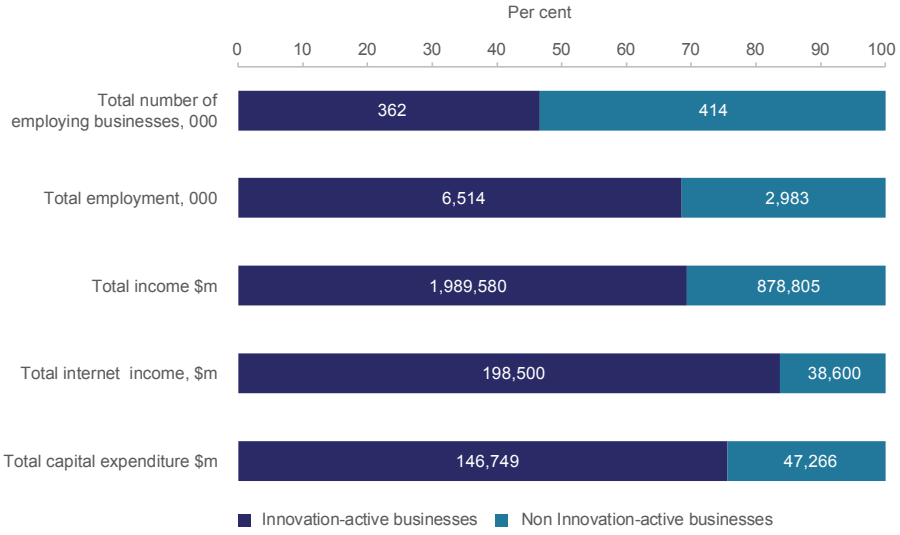
income.[75] These findings reinforce other studies that show that innovative sectors can disproportionately drive job creation and income growth.[76] These benefits also accrue to surrounding sectors and communities. The multiplier effect on local service employment and income can be as high as five times in high-tech industries such as advanced manufacturing, information and communications technology (ICT) and pharmaceuticals.[77]

Larger businesses are more likely to innovate. Controlling for size, data show that between 2007–08 and 2011–12, average gross profit per employee was $20,400 for innovation-active businesses. This was 47% higher than non-innovation-active businesses at $13,900.[78]

We need to be consistently inventive, yet always compelling.

—Timothy Calnin, Australian Chamber Orchestra

Figure 2.1 Total estimated number of employing businesses that are innovation-active and their contribution to employment, income and capital investment, 2011–12



Source: ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry and ABS (2014) Selected characteristics of Australian business, 2011–12, cat. no. 8167.0, ABS, Canberra.

Notes: Estimates of the number of businesses operating in Australia can be derived from a number of sources within the Australian Bureau of Statistics. Variations will occur because of differing data sources, differing scope and coverage definitions between surveys, as well as variations due to sampling and non-sampling error.

75 Gross profit per firm was $398 million for innovators versus $162 million for non-innovators when averaged across all business sizes and sectors. There is a size effect given that large firms (large employment, investment and exports) are more likely to be innovating in any given year. However, previous reports have also shown that the effect of innovation on small and medium-sized enterprise performance is more extreme than for large firms. So the difference between innovators and non-innovators is not purely a size effect.

76 van Reenen J (1996) The creation and capture of rents: Wages and innovation in a panel of UK companies, *Quarterly Journal of Economics* 11:195–226.

77 Moretti E (2012) *The new geography of jobs*, Houghton Mifflin Harcourt, Boston, p.13.

78 Australian Government Department of Industry's analysis of customised ABS Business Characteristics Survey data, cat. no. 8167.0.

Box 2.1 Feature: the RØDE microphones story

By Peter Freedman, Managing Director and President, RØDE Microphones & Event Electronics

Winning lotto is an interesting concept. Buy a ticket, wait a week or so and then lucky you, 'instant millionaire'. Much like the RØDE microphones story. If you believe that, then I have a really nice Sydney Harbour bridge for sale too.

Building my company from a literal bomb site to one of the world's most successful pro audio brands has taken 24 years of blood, sweat and lots of tears. There is one ingredient missing in that sentence and it is integral to success—luck. You can't beat being in the right place at the right time. Luck is an interesting concept. I have heard it defined as being where 'opportunity meets preparation' and I totally agree with that. What is missing in that conceptual statement is the need to seize the opportunity and, then as the world changes, move with that change and never give up, no matter how hard things get.

RØDE grew by 47% in the past year. We export to more than 100 countries, are number one in many of the categories we address and now sell half a million microphones annually. I can remember dreaming of selling 500 microphones per year!

So how are we able to manufacture here in Australia when so many people say it is impossible? We don't sell ultra-high-technology, high-cost products either. We design and manufacture world-leading consumer goods that in many cases sell for less than $150.00 retail.

We do great business in China too. Selling snow to the Eskimos!

It's not a big secret, but it is not an easy feat to emulate either. In the past 24 years, we have built up a solid brand that is now known worldwide. There is not a major city where you can't find RØDE for sale. We have more than 4000 dealers and most have been with us for 20 years. This is the pipeline. This distribution network took a lot of work to build. That is how we grow. We fill the pipeline with a continuous stream of industry-beating product, at a quality and price our competitors can't match.

A famous ancient Chinese proverb says, 'A journey of a thousand miles begins with the first step'. I started selling RØDE by getting on a plane to LA [Los Angeles] with a ticket I had bought on a credit card. I would not have been able to pay for if I didn't sell some mics. I literally walked the streets of LA going from shop to shop with a backpack that contained a couple of mics. I did make a sale and the journey began.

Of course, this is where the ‘right place at the right time’ comes into play. We had a product that was effectively unique when you talked price, performance and an aggressive Australian salesman pitching it. A good combination! Now there are more than 60 competitors with similar or lower prices to what we had then. It would have been hard or indeed impossible to build what we now have at this time. That’s not to say there isn’t an opportunity now. I laugh when people say things like ‘yeah, back in the day it was so easy’. There is no ‘back in the day’. The day is now, tomorrow, next year or whenever you want to start.

RØDE has changed so much since those early days. We did not make much of the product we sold. We modified a Chinese microphone that we bought at very low cost. I could see then that to achieve excellence in the long term, and to be safe, we had to be in control of our destiny. We had to control our design and manufacturing, and so I slowly started to buy machinery and develop our own technology.

There is a lot of talk today about advanced manufacturing and innovation. Many are preaching companies must be innovative or they won’t succeed. This is not true. RØDE was far from innovative when we started. If excellence and innovation are in your heart, just by being in your chosen arena and ‘giving it a go’, they will come.

So here we are in 2014. We have a huge barrier to entry for anyone wanting to take us on no matter where they come from. We have $25 million in machinery and a great deal of specialised technology. We have strong intellectual property and some of the most amazing engineering talent in the world all working at our headquarters. We have people in advanced electronics, acoustics, software, industrial design, micromachining and tool making.

High labour costs are irrelevant to us. Even at ten times the cost of wages in China, through the use of robotics, we are more efficient and produce much higher quality. We employ 140 people in Australia and that is growing rapidly. RØDE will soon employ hundreds of people, but we will still be able to make low-cost consumer products here, because we do not add much ‘hands-on’ labour. We also have our own in house advertising agency and spend millions per year driving sales.

If I had to define why we are successful now I would say it is a perfect combination of design ability based on 40 years of industry experience, the ability to produce these products at ultra-competitive prices, having a worldwide team of distributors and dealers (the pipe line) and, last but incredibly importantly, marketing to drive customers into a purchase.

Nothing happens until someone sells something. This is the fundamental of business. Sell and make profit. That was true and solidly in my mind on day one of RØDE and it is at the core of everything we do today.

The internet has offered us all an amazing opportunity to communicate with millions of potential customers. This was impossible when we started. Back in the late 1980s and early 1990s magazines ruled. The cost for a single colour page was incredibly high, and you would be lucky to get 5000 eyes across it. Along with that one had a seemingly insurmountable task to convey a succinct and meaningful message that would drive sales.

A famous quote in the era of traditional advertising was ‘I know 50% of what we spend on marketing is a waste of money, I just don’t know which 50%!’ Today real and meaningful metrics on online traffic and clicks to purchase are easy and the norm. There is no need to guess what is working and what is not, and we

constantly change to fine-tune our communications. We know second by second how many people are on our site, what they look at and where they navigate to.

A vast amount of our sales are online purchases now, and while traditional stores will remain in some categories, online sales have and will continue to squeeze out small businesses whose model is no longer viable. Today, we literally reach millions of people with our communications. We don't do magazine advertisements, we don't do trade shows, we are online! We focus on education. We get involved in these people's lives, their hobbies, their dreams. We offer solutions to their problems.

We have full time staff for social media. We have more than 100,000 followers on Facebook alone and it rises daily. We have a group of RØDE friends around the world who are influential industry-leading bloggers. These associates have hundreds of thousands of followers. Through this extended network, and other online portals, we can blast out a message to hundreds of thousands of people around the world at any time. And we do!

A recent example of the power of our online communication is our latest short film festival, called My RØDE Reel. We offered $80,000 in prizes. The only proviso was that the audio used some form of RØDE microphone. We also had to receive a behind the scene film to gauge how they completed the audio. The response was phenomenal. We ended up with just under 1200 entries from 76 countries. My RØDE REEL is now the world's biggest short film festival. Bigger than Tropfest at 700 entries! Now that's marketing!

There are so many things I have not touched on that now keep RØDE at the forefront of the industry, but I hope I have offered some insight into what we have done and why we have done it that way.

There are two last things I want to leave you with. Do not listen to anyone who says 'you can't do it'. You may have to change things. You may have to risk a great deal, but if you want success badly enough and you don't give up, it will come.

And lastly, as Andy Grove, one of the founders of Intel, said, 'only the paranoid survive'.

2.2 The contribution of innovation to businesses' performance

The link between innovation and business performance is further demonstrated in Figure 2.2 (see Box 2.1 for a case study). These data show that innovation drives business productivity growth, employment growth, increasing market diversification (via increasing the range of goods and services being offered and the number of export markets being targeted by innovative businesses) and a range of other performance outcomes.[79] Between 2006–07 and 2011–12, these results have been very consistent across all business sizes and sectors, which suggest that innovation is an effective tool to grow a competitive business.[80] Compared with businesses that don't innovate, innovative Australian businesses are:

- 31% more likely to increase income and 46% more likely to report increased profitability
- twice as likely to export and five times more likely to increase the number of export markets targeted
- twice as likely to report increased productivity, employment and training
- three times more likely to increase investment in ICT
- three times more likely to increase the range of goods and services offered.

These results are consistent with research that demonstrates a positive relationship between innovation, competitiveness and, in particular, exporting and productivity growth.[81] Recent research shows that the salary, employment and productivity benefits can persist for years after an innovation is introduced.[82]

The data in Figure 2.2 is based on self-reporting by business owners and managers. We asked the Australian Bureau of Statistics (ABS) to match data on innovation with firm financial performance. There is a significant difference between innovators and non-innovators in sales performance (Figure 2.3). The data show a significant positive association between the

79 ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry. These relationships are statistically significant. Analysis of variance tests show the correlation between innovation and jobs growth, innovation and productivity growth, and innovation and growth in the range of goods and services being offered is highly significant ($P < 0.0001$).

80 See Australian Government Department of Industry (2013) *Australian Innovation System Report 2013*, Canberra, pp. 4–56, www.industry.gov.au/aisreport.

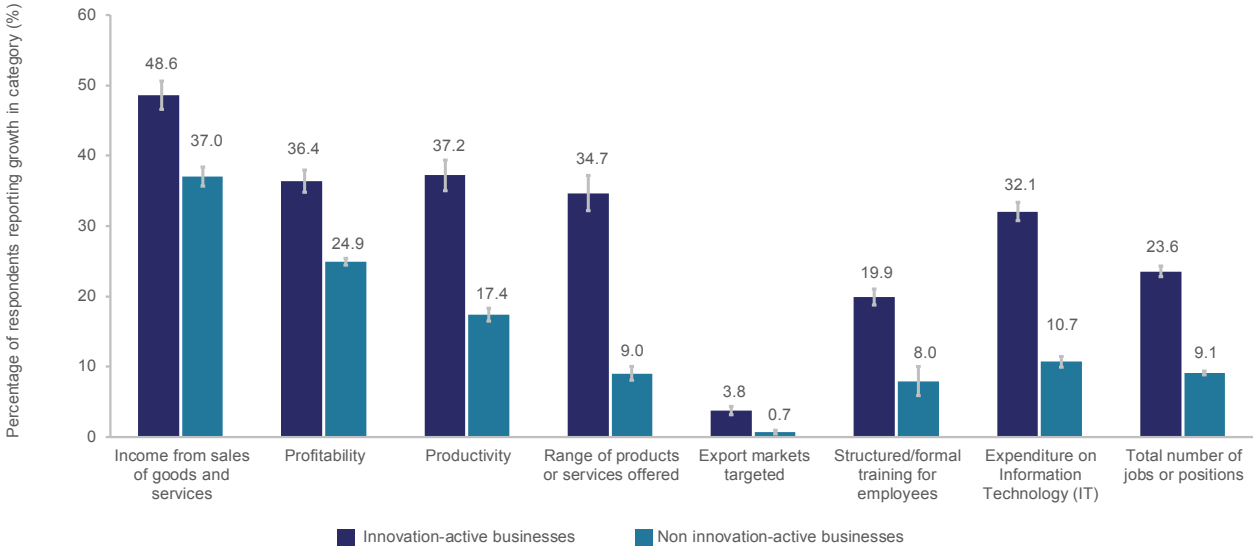
81 Hall BH (2011) *Innovation and productivity*, Nordic Economic Policy Conference on productivity and competitiveness; Soames L et al. (2011) *Competition, innovation and productivity in Australian businesses*, Productivity Commission and Australian Bureau of Statistics Research Paper, ABS cat. no. 1351.0.55.035; Fagerberg J (2013) *Innovation: a new guide*, Working Papers on Innovation Studies 20131119, Centre for Technology, Innovation and Culture, University of Oslo; and Hashi I & Stojčić N (2013) The impact of innovation activities on firm performance using a multi-stage model: evidence from the Community Innovation Survey 4, *Research Policy* 42:353–66.

82 Balasubramanian N & Sivadasan J (2011) What happens when firms patent? New evidence from US manufacturing census data, *Review of Economics and Statistics* 93:126–46.

frequency of innovation, and both annual sales and annual sales growth. Between 2009–10 and 2011–12, median annual sales growth for non-innovators was $4,245 and average sales were $1.3 million. By contrast, persistent innovators (those that innovated in all three years) had the highest median annual sales growth of $243,764 and the highest average sales of $5.253 million.[83]

Large firms are much more likely to innovate and more likely to be persistent innovators than small businesses. Innovative large firms can therefore explain some of the variation in financial performance between innovators and non-innovators. Average sales for non-innovative large firms were $385.4 million between 2009–10 and 2011–12. Persistent large innovators had average sales of $518.6 million during the same period. Analysis of variance shows that there is a statistically significant effect of innovation status on financial performance for small and medium-sized firms ($P < 0.05$). Average sales for non-innovative SMEs were $1.87 million between 2009–10 and 2011–12. Persistent SME innovators had average sales of $5.34 million during the same period. The majority of large firms will not have grown into large firms without some degree of innovation. So, the association with firm size is partly a product of past innovation.

Figure 2.2 Average increases in business performance and activities compared to the previous year, by innovation status, 2006–07 to 2011–12

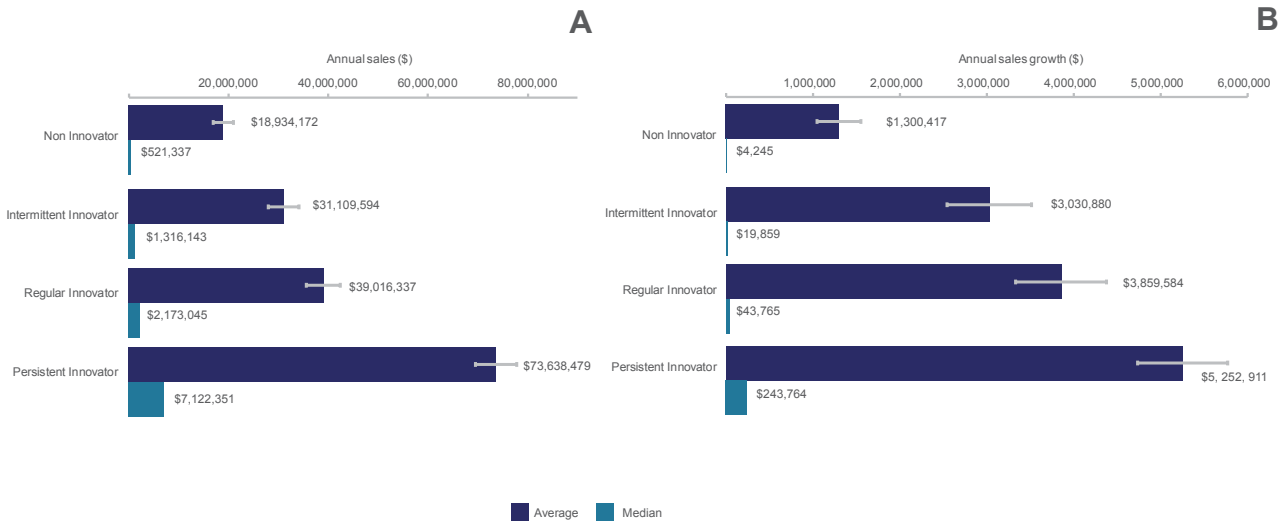


Note: Averages and standard errors are generated from year-on-year variation in each indicator by the Australian Government Department of Industry.

Source: ABS (various) Selected characteristics of Australian business, 2006–07 to 2011–12, cat. no. 8167.0, ABS, Canberra.

83 These figures include all firm sizes and industries. There is a greater proportion of large firms in the persistent innovator category.

Figure 2.3 Annual sales (A) and annual sales growth (B), by frequency of innovation, 2009–10 to 2011–12



When you're small and you're growing rapidly, a key innovation will have a disproportionately large effect on your business.

—Ian Gardiner, Viocorp

Notes: Innovation frequency refers to the number of times a business reported introducing an innovation between 2009–10 and 2011–12. Intermittent, regular and persistent innovators introduced innovations in one, two and three out of three years, respectively. Both median and average data are provided because large firms drive up average sales.

Source: ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

2.2.1 The relationship between innovation and exports

Approximately 37,000 innovation-active businesses sold goods or services to overseas markets in 2012–13.[84] The number was lower for non-innovative exporters at approximately 23,000. Total export income for goods and services was $301.5 billion in 2012–13.[85]

We further examine the relationship between innovation and exporting activity, and its influence on business profitability and productivity in Figure A.1 (see Appendix A). The 2011–12 results show that innovation increases the likelihood of SME productivity growth for both exporting and non-exporting businesses. Innovative exporters are significantly more likely to report growth in productivity than non-innovative businesses. These results are similar for business income and sales growth, growth in the range of goods and services offered, and growth in employment and training. The effect of innovation on SME profitability was less pronounced, but still showed a significant positive association.

The incidence of exporting activity appears to be less influential on productivity than innovation. Exporting appears to offer a limited additional productivity advantage of its own (increasing the likelihood of productivity

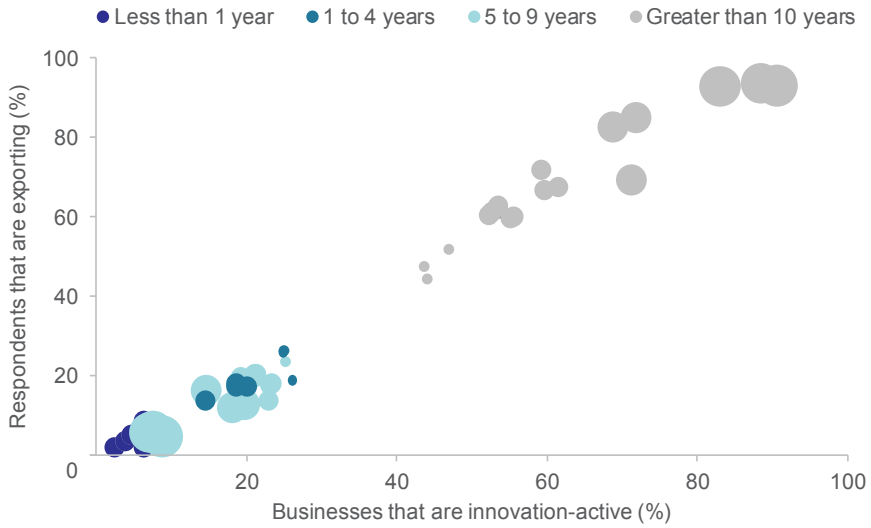
84 ABS (2014) *Selected characteristics of Australian business*, 2013–14, cat. no. 8167.0, ABS, Canberra.

85 DFAT (2013) *Australia's trade in goods and services 2013–14*, www.dfat.gov.au/publications/tgs/trade-goods-services-fy-2013–14.html.

growth by a margin of 20–30% between non-innovative exporters and non-innovative, non-exporting businesses). This effect has been described as learning by exporting,[86] but this is a small impact compared with innovation (doubling the likelihood of productivity growth; Figure A.1). For large firms, there was no significant effect of innovation or exports on the likelihood of business productivity or profitability growth. The variation in the data are very high for these firms.

The difference in the likelihood of exporting between innovation-active and non-innovation–active businesses is greater than three-fold for SMEs, but averages around 60% higher for large businesses. There is a significant correlation between export activity and innovation activity across all business sizes and ages in Australia (Figure 2.4; Figure A.2). Innovation and exporting activity move in tandem, and the relationship is almost one-to-one. The data indicate that young SMEs are both more innovative and more likely to be exporting than young large businesses. Young large businesses may be largely the result of restructuring or multinationals setting up subsidiaries in Australia that may be focused on capturing the domestic market. As firms age, the variation between firm size becomes larger. For firms that are more than nine years old, the majority are innovating and exporting. Almost all older, large firms are both exporting and innovating. Around 50% of SMEs older than nine years are innovating and exporting.

Figure 2.4 Relationship between export activity and innovation, by business size, age and innovation status, 2010–11 and 2012–13



Note: Each point represents a different firm size class and year. Microsized businesses (0–4 employees) have the smallest bubble size, then small-sized (5–19 employees) and medium-sized (20–199 employees) businesses. Large businesses (200 or more employees) have the largest bubble size. Business age data are not available for non-innovators.

Source: ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

86 Fernandes A M & Isgut A (2005) *Learning-by-doing, learning-by-exporting and productivity: evidence from Colombia*, World Bank Policy Research Working Paper 3554.

Average export income for innovative SMEs in 2011–12 ($842,808) was double that of non-innovators ($419,684).[87] Australian SME export income shows a highly skewed distribution towards zero export income. Most Australian SMEs are not exporting, but of those SMEs that do, median export income was $20,142 and $1874 in 2011–12 for innovators and non-innovators, respectively.[88]

Large businesses are generally thought of as being more effective exporters through economies of scale and scope.[89] Large firms have other trade advantages beyond innovative capacity, such as personal or organisational networks. SMEs, on the other hand, must leverage a range of capabilities to be internationally competitive—innovation being a primary one.[90]

We're always trying to stay on top of the next big thing. Whether it's going to tradeshows, being involved in networking events or being on the boards of new developments.

—Ben Bartlett, Lumen Australia

Exporting businesses are significantly more likely to engage in innovation of all types compared to non-exporting businesses (Figure A.3). These data confirm a previous econometric study by Soames et al. (2011) from 2006–07 that also showed that exporting is strongly and positively associated with innovation.[91] Their analysis suggested that innovation may be more important for breaking into export markets than for increasing export intensity. SME exporters engage in significantly more product, process, organisation and marketing innovation than their non-exporting counterparts. Large exporters are more likely to be engaged in product and process innovation only. Large, innovative, domestic firms are equally likely as their exporting counterparts to engage in organisational and marketing innovation.[92]

2.2.2 The impact of the degree of innovation novelty on business performance

Not all innovation is the same. By definition, all innovations must have a degree of novelty. At a minimum, an innovation must be new to the firm. Higher degrees of novelty can be broadly categorised as new to the market. Innovations are new to the market when the firm is the first to introduce the innovation on its market. The market is simply defined as the firm and its competitors, and can include a geographic region or product line. Within this category, there is new-to-industry, new-to-country and new-to-world innovation. An innovation is new to the world when the firm is the first to introduce the innovation for all markets and industries, domestic and international (see Box 2.2 for an example of an Australian new-to-world innovation).

87 Australian Government Department of Industry customised data request based on the ABS Business Characteristics Survey, cat. no. 8167.0.

88 Ibid.

89 Wagner J (2001) A note on the firm-size export relationship, *Small business economics* 17:229–37.

90 Knight GA & Cavusgil ST (1996) The Born Global firm: a challenge to traditional internationalization theory, *Advances in International Marketing* 8:11–26.

91 Soames L et al. (2011) *Competition, innovation and productivity in Australian businesses*, Productivity Commission and Australian Bureau of Statistics research paper, Canberra.

92 ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

Box 2.2 Case study: the Australian Chamber Orchestra

The Australian Chamber Orchestra (ACO) is a Sydney-based ensemble that is renowned for its innovative approach to programming and performance making. In a climate where many orchestras and conventional music institutions have narrowed their repertoire through conservative programming, the ACO has expanded into new forms of performance and created new experiences for their audiences. From devising a Berlin Cabaret with Barry Humphries to creating a surf film that explores the music of Beethoven and Shostakovich, the ACO has stretched the orchestral art form and forged an identity that resonates far beyond the classical ear.

Talking with ACO General Manager Timothy Calnin, it is clear that collaborating with artists outside the classical world, and even outside the musical world, is vital for sustaining the ensemble's reputation as 'consistently inventive, yet always compelling'. The ACO regularly collaborates with other artists in a way that meaningfully incorporates the orchestra's expertise with that of their partners.

'It's a proper collaborative basis, rather than just inviting a guest to be a featured soloist with a backing band', says Calnin. The orchestra seeks to interpret music in a new way so that it lends itself to old and new audiences.

The leadership of Artistic Director Richard Tognetti has been central to the development of these collaborations. Tognetti, who has been with the ensemble for more than 20 years, has encouraged the ACO 'to become more courageous and more inventive', says Calnin. 'He generates new ideas and adjusts his role according to the artist that the ACO is collaborating with'. For example, in 2005, Tognetti worked with contemporary art photographer Bill Henson to fuse image and music, and create an experience for audiences that was half visual dreamscape and half haunting soundscape. 'It brought together Bill's visual world with Richard's sound world', says Calnin.

More recently, the ACO has collaborated to develop a new-to-world performance product that changes the way audiences hear and perceive classical music. Working with MOD Productions, a visual media company that specialises in interactive content, the ensemble developed ACO Virtual, an interactive audiovisual installation.

In the installation, life-size moving images of 14 musicians are projected around a room, encircling the audience, with music emanating from each individual performer. 'It gives people the chance to get inside the music, to stand in the middle of the orchestra', says Calnin. Another dimension to the installation is added with the use of an iPad. The iPad enables audiences to control what they're hearing, essentially putting them in the position of the conductor.

Talking about the impetus for the project Calnin states, 'the idea was to do with audience reach'. The ensemble's rigorous performance schedule of 85 main-stage concerts and two international tours per year meant that the orchestra was unable

to regularly be in many regional centres of Australia. In collaborating with MOD Productions, the ACO 'wanted to be able to find a meaningful and interesting way of reaching those audiences—something that was going to be more engrossing than a recording or filming'.

Through their collaboration with MOD Productions, the ACO was indeed able to extend their reach and tap into new markets. The response to the ACO Virtual project has far exceeded its intended regional audience. Along with touring regional centres such as Bathurst and Port Macquarie, galleries in Australian capital cities and overseas have also wanted to host the installation and share the new performance experience. ACO Virtual has also been developed into an educational app for iPads, enabling students to insert themselves into the orchestra and play along with the ensemble.

Coming together and working with individuals and groups that are outside the classical field of music are important to the ACO for two key reasons.

Firstly, collaboration with a partner can tap into a different sector of the audience. Secondly, collaborating creates opportunities for the ensemble to cross-fertilise ideas with other artists and to produce performance pieces that strengthen their inventive identity.

Yet, as Calnin stresses, collaboration cannot be for collaboration's sake. 'Every project has to have a grounding in the integrity of the music. It's the combination of innovation (and collaboration) grounded in artistic integrity', he states.

Young student playing along with ACO Virtual.

ACO Virtual

Image credit: Jack Saltmiras

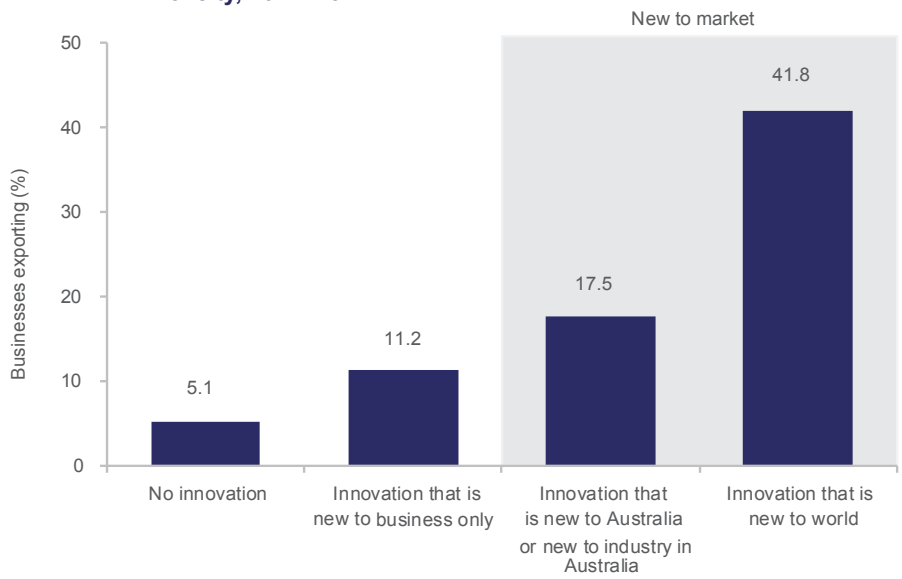
Firms that are first in the world to develop innovations represent the technology or innovation frontier.[93] This degree of novelty can have a big impact on the international competitiveness of business. Not only are Australian world-first innovators more than eight times more likely to export than non-innovators (Figure 2.5), they are twice as likely to be exporting than businesses introducing less novel forms of new-to-market innovation (new to

93 OECD/EC (2005) *Oslo manual: guidelines for collecting and interpreting innovation data*, OECD Publishing, p. 58.

Australia or new to the industry innovations). This association is strongest in SMEs; for large firms, the effect is smaller.[94] Recent econometric analysis found no significant influence of firm size on the degree of innovation novelty, suggesting that innovation may be more important for breaking into export markets than for increasing export intensity.[95]

A recent Productivity Commission and ABS econometric analysis[96] found a significant association between market share (as a measure of firm performance) and a high degree of innovation novelty. In this study, Australian businesses with a large market share (>50%) were 36%, 53% and 89% more likely to be introducing new-to-industry, new-to-Australia and new-to-world innovations, respectively.

Figure 2.5 Australian business exporting activity by innovation status and novelty, 2012–13



Source: ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

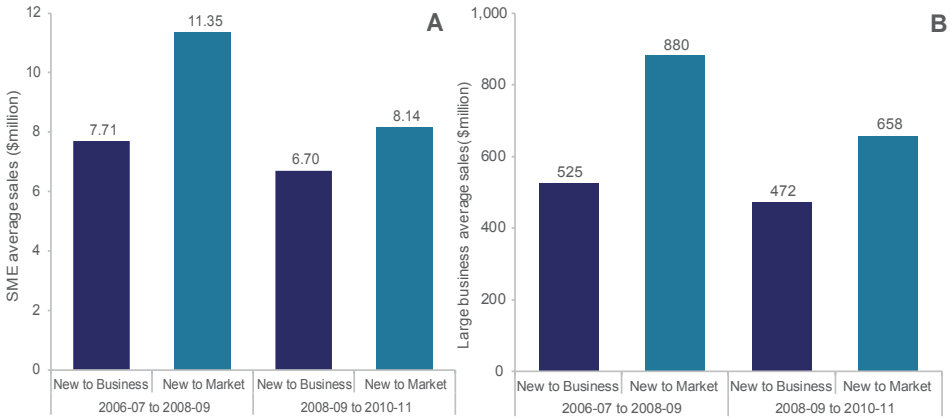
Figures 2.6A and 2.6B show average annual sales data for SMEs and large businesses, respectively, by innovation novelty for two different three-year periods. There is an increase in average annual sales when firms undertake new-to-market innovation. This is particularly significant for large businesses, which account for 95% of Australia's exports. For SMEs, which account for only 5% of Australia's exports, the influence of new-to-market innovation is positive, but not always statistically significant.

94 ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

95 Soames L et al. (2011) *Competition, innovation and productivity in Australian businesses*, Productivity Commission and Australian Bureau of Statistics research paper, cat. no. 1351.0.55.035, Canberra.

96 Ibid.

Figure 2.6 Average annual sales for SMEs (A) and large businesses (B) by innovation novelty, 2006–07 to 2008–09 and 2008–09 to 2010–11



Source: ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

There are direct competitors overseas. We tend to win because we are local. You can have a cup of coffee here and talk to the engineering team directly. We are very focused around local knowledge.

—Ian Gardiner, Viocorp

Australia has low rates of new-to-market innovation relative to European Union (EU) countries. Figure 2.7 suggests that Australia's overall rates of innovation are moderate relative to other EU countries, but that we rank poorly against leading EU countries on new-to-market innovation.[97] Australia is principally a nation of adopters and modifiers, being well behind other OECD countries such as New Zealand, Canada, Japan and Korea on new-to-market innovation. A strong business focus on cost reduction may explain a preference for the adoption and modification of existing innovations, rather than new-to-world or radical innovation.

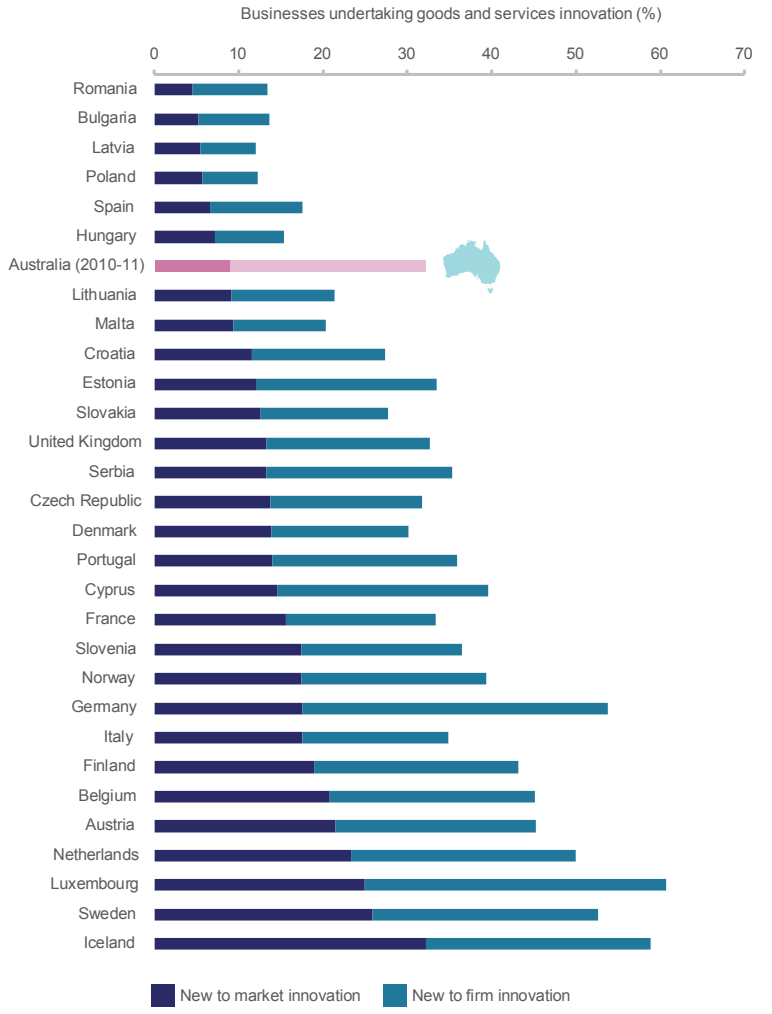
Australia has experienced an absolute decline in new-to-market goods and services innovation since the early 2000s (Figure A.4). Intermediate levels of novelty (new-to-industry and new-to-Australia innovation) have declined and stayed low since 2001–03. Between 2001–2003 and 2010–11, the percentage of Australian businesses introducing new-to-world innovations had halved from 1.53% to 0.78%, with a recent encouraging resurgence back to 2.20% in 2012–13 (Figure A.4). By contrast, the lowest degree of novelty, new-to-firm goods and services innovation, has increased from 9.52% to 15.00% in 2012–13.

The degree of new-to-market goods and services innovation varies considerably across different business sectors and sizes in Australia (Figure A.5). Large businesses are more likely to be undertaking new-to-market innovation than SMEs in absolute terms. However, the underlying data suggest that Australian microbusinesses (with 0–4 employees) do relatively more new-to-world innovation than large firms (13.9% vs. 8.6% of goods and services). Although Australia's new-to-market innovation ranks poorly against many of our EU counterparts (Figure 2.7), several of our sectors

97 Australian Government Department of Industry (2011) *Australian Innovation System Report 2011*, p. 23, www.industry.gov.au/aisreport

perform well above the national average on new-to-market innovation. Manufacturing; wholesale trade; information, media and telecommunications; and professional, scientific and technical services perform well above the national average in absolute terms (Figure A.5).

Figure 2.7 Country comparison of innovation novelty, 2010



Notes: A limited number of Organisation for Economic Co-operation and Development countries are available for analysis. European Union (EU) countries use 'new-to-market innovators' instead of 'new-to-world innovators' as the highest reported degree of novelty. Australian data have been adjusted to match the EU definitions where possible. Data are for firms with more than 10 employees. Australian data are for all industries in 2010–11, and excludes ongoing or abandoned innovation projects. EU firms are for all core NACE activities related to innovation activities (Divisions B, C, D, E, G46, H, J58, J61, J62, J63, K and M71).

Source: Eurostat, Community Innovation Survey 7 (2010); and ABS (2011) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

2.3 Labour productivity performance

Many economists consider productivity of the private sector as the best measure of its competitiveness. United States (US) research shows that high-performing firms can have three times the labour productivity and twice the total factor productivity of the laggard firms.[98] Similar results have been found for the total factor productivity of high-performing Australian service firms.[99]

Australia's productivity performance has been falling behind that of most other developed economies for more than a decade.[100] Australia is not as resource efficient as other advanced economies. Australia's level of output per unit of carbon dioxide, water, energy and material productivity is low by OECD standards (see Table 1.1 in Chapter 1). Australia's average annual labour productivity growth rate between 2001 and 2012 was 0.8%, half that of the OECD average at 1.6%, and well behind the top five performing countries at 3.7%.[101] Australia's aggregate labour productivity performance is moderately ranked at 12th against other OECD countries (Table 1.1). Labour productivity has picked up recently, having grown by an average annual rate of 3.0% in the three years up to and including 2013–14.

Labour productivity is the most readily available productivity indicator for international comparisons at the industry level.[102] Australia ranks 12th of all OECD countries, with a relatively high labour productivity of US$55.5 per hour worked in 2013 (above the OECD average of US$47.4 per hour worked).

Industry sectors in Australia show a wide distribution of labour productivity performance.[103] Mining is the only sector with a labour productivity that is a superior performer, well above the OECD median. All other sectors are at or below the OECD median and well behind the top three countries (Figure 2.8). The differences in labour productivity between industries are partly driven by differences in the capital intensity of production between industries. Workers in mining have their labour combined with much larger amounts of capital equipment than in retail, and hence an hour of their labour produces a larger output value.

In the long term, total factor or multifactor[104] productivity demonstrates how much the nation has improved in terms of the way it produces goods and

98 Syverson C (2013) The importance of measuring dispersion in firm-level outcomes, *IZA World of Labour*, Bloomsbury, home.uchicago.edu/syverson.

99 Boedker C et al. (2011) *Leadership, culture and management practices of high-performing workplaces in Australia: the high-performing workplaces index*, Society of Knowledge Economics, Sydney.

100 Productivity Commission (2014) Productivity update, www.pc.gov.au/__data/assets/pdf_file/0008/135935/productivity-update-2014.pdf.

101 OECD (2013) *Science, technology and industry scoreboard 2013*, Figure 1.1, Labour productivity growth based on hours worked, total economy level, 2001–12.

102 Absolute country by industry total factor productivity estimates are unavailable for Australia.

103 Eslake S (2011) *Productivity: the lost decade*, conference paper, Reserve Bank of Australia, Canberra, www.rba.gov.au/publications/confs/2011/eslake.html.

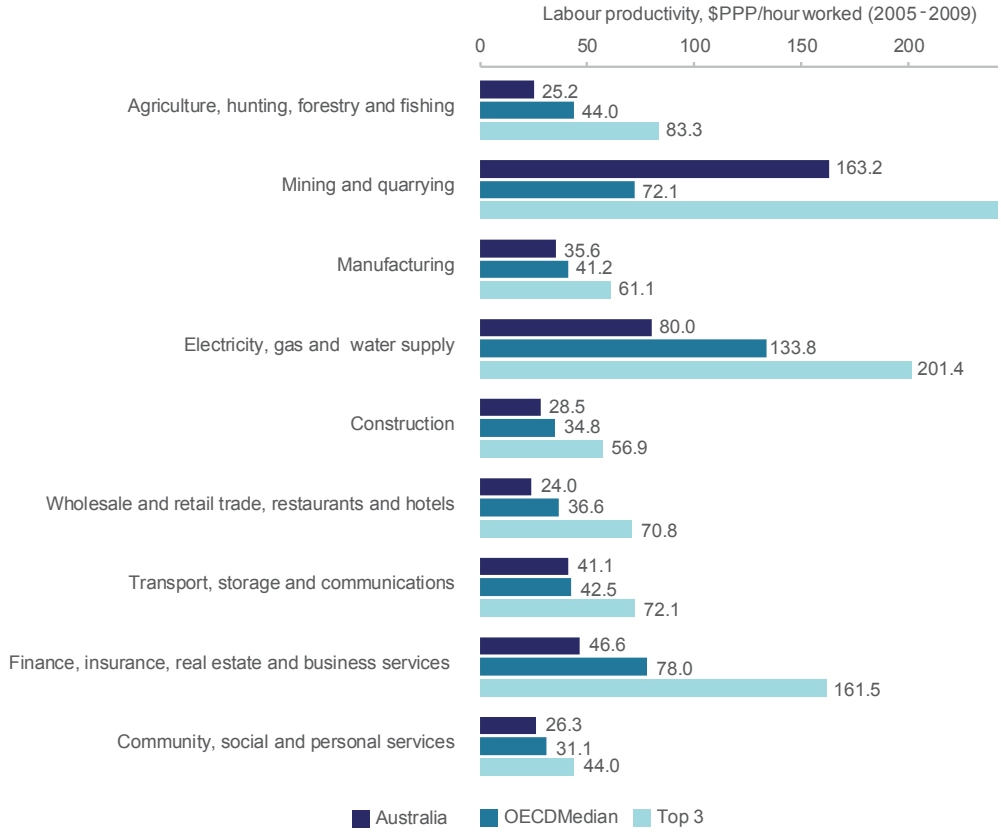
104 Labour and capital inputs only.

services. Between 2001–02 and 2011–12, aggregate multifactor productivity in Australia declined by 2.1%.[105] Many of our primarily domestic service industries (excluding utilities) have been increasing in multifactor productivity since 1990–91. By contrast, many of our exporting industries have either maintained a flat multifactor productivity trend (manufacturing) or declined (mining) in the same period. Agriculture, forestry and fishing is the only exporting sector where multifactor productivity has improved.[106]

You're only as good as your last cup of coffee … if your brand is disconnected from what you do on a day-to-day basis then you become irrelevant.

—Michael Drummond, Di Bella Coffee

Figure 2.8 Average labour productivity in selected OECD countries, by sector, 2005–09



Source: OECD STAN Database for Structural Analysis; ABS (2014) Labour Force, Australia, Detailed, Quarterly, May 2014, cat. no. 6291.0.55.003

2.4 Innovation performance in Australian businesses

Previous sections have highlighted the relationship between innovation and business performance. The following sections provide trends in innovation-related activities in Australia and, where possible, international comparisons of Australia's innovation performance.

105 Australian Bureau of Statistics (2012) *Australian system of national accounts*, 2011–12, cat. no. 5204.0, ABS, Canberra, www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/5204.0Main+Features12011-12.

106 Australian Bureau of Statistics (2013) E*stimates of industry multifactor productivity, 2013–14*, cat. no. 5260.0.55.002, ABS, Canberra, www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/5260.0.55.002Main+Features12013–14?OpenDocument

2.4.1 Investment in innovation

Reported expenditure on innovation by Australian firms in 2012–13 was estimated to be between $28 billion and $34 billion, an increase on the $23–29 billion estimated for 2010–11.[107]

The majority of this investment is experimental development: systematic work drawing on research and/or experience, which is directed to producing new goods or services, or improving substantially those that exist. Business expenditure on research and development (BERD) was $18.3 billion in 2011–12, of which $11.4 billion (62%) was experimental development.[108]

A high proportion (43%) of innovation-active businesses reported no expenditure on innovation in 2012–13.[109] This may represent confusion in survey respondents' minds about the true cost of innovation. More likely, this response could be explained by the fact that Australian businesses are high adopters of innovation developed outside the business. Where these adopted innovations are non-technological, they may be considered relatively 'cost free' from a business manager's perspective.

After a decade of high growth, which peaked in 2008 (at 1.37%), the latest data show that Australia's BERD, as a proportion of gross domestic product (GDP), dropped for the third consecutive year to 1.24% in 2011–12 (Table 2.1). This is just below the OECD average of 1.3 and ranks Australia 15th. When BERD to industry value-added ratios are standardised, (by assuming each country has the average OECD industrial structure) Australia's ratio increases from 1.91 to 2.06, but its OECD ranking falls from 13th to 15th for 2011.[110] Large firms in Australia accounted for 66% of total BERD in 2011–12. The manufacturing sector remained the largest contributor to total BERD in 2011–12.

The academic evidence suggests that BERD leads to more novel inventions upon which innovations can be based and allows for a greater understanding of other firms' innovations.[111] In most OECD countries, businesses that do R&D themselves are much more likely to introduce new-to-market goods or services.[112]

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107 The ABS uses three different techniques to estimate the total investment in innovation. See ABS (2013) *Research and experimental development, businesses, Australia, 2011–12*, cat. no. 8104.0, ABS, Canberra.

108 ABS (2013) *Research and experimental development, businesses, Australia, 2011–12*, cat. no. 8104.0, ABS, Canberra.

109 ABS (2014) *Innovation in Australian business, 2013–14*, Appendix 2, cat. no. 8158.0, ABS, Canberra.

110 OECD (2013) *OECD science, technology and industry scoreboard 2013*, OECD Publishing, p. 220.

111 Griliches Z (1998) R&D and productivity: the econometric evidence, University of Chicago Press, Chicago; OECD (2011) O*ECD innovation strategy: getting a head start on tomorrow*, OECD Publishing; Katila R (2000) Using patent data to measure performance, *International Journal of Business Performance Measurement* 2:180–93; and Godoe H (2000) Innovation regimes, R&D and radical innovations in telecommunications, Research Policy 29:1033–46.

112 OECD (2010) *Measuring innovation: a new perspective*, OECD Publishing, p. 23.

Australian manufacturing and service firms have the lowest and second lowest proportions of innovative businesses investing in R&D by OECD standards (Figure A.6). This may explain our low degree of new-to-market innovation. Agriculture and mining sector comparisons are not available, although it is worth noting that both these sectors have high R&D intensities by OECD standards, and are areas of export specialisation for Australia (see Chapter 3).

Investment in innovation (especially design innovation) is to stay ahead of the competition.

—Anton Pemmer, Bottles of Australia

Box 2.3 is a case study of how being innovative and investing in R&D has benefitted an Australian company.

Box 2.3 Case study: Viocorp[113]

Video may not have killed the radio star. But the proliferation of device-based and internet-enabled video content has certainly changed the way companies do promotions.

Australian-based Viocorp has been at the vanguard of this process. Initially, it toyed with the concept of corporate video email back in 2002 as a kind of video alternative to email communications. However, as the technology evolved and the ease of creating content became apparent, so did the product. Rather than creating content, VioCorp now sells its VioStream software as a video content management system—a kind of corporate YouTube—for private firms, government departments and others as a way to market their video content. They also do live webcasting for clients.

VioCorp cofounder Ian Gardiner put his value proposition simply, 'It's about saying "hey, your CEO is appearing on stage next week, so do you want us to come along, capture it and put it online"'.

The idea caught on. The company now has about 130 customers paying around $30,000–40,000 a year. It is a good example of a niche high-tech Australian enterprise that has some significant R&D and employment growth behind it. There are now about 50 employees at VioCorp—25–30 of whom are researchers or engineers. It also has one overseas office in Singapore, with around 10% of its revenue generated offshore.

Ian offers some interesting anecdotes about what the tech scene was like in Australia in the early 2000s.

'It was very hard. We had no support. The few VCs [venture capitalists] around in Australia at that time were very old school. The only thing that kept us going was our refusal to give up and the knowledge that we had a great product'.

113 Based on interview conducted 23 April 2014.

According to Ian, the situation is much better now. Australia's rates of VC per head of population are still tiny compared to a world leader like Israel. But Ian does not see lack of VC or angel investors as the main hurdle. 'If the business is great then the money will follow. Money is global enough and smart enough to follow the talent'.

Ian explains VioCorp's approach to innovation and R&D.

'We've always been an early adopter. Sometimes as the early adopter you'll get a lot of things wrong. But the challenge is to survive long enough and to not get things so spectacularly wrong that it kills you. That's one great thing about the internet. It allows you to take a lot of small risks, as it's not that expensive anymore to go out and try something'.

The only failure that really counts, according to Ian, is completely running out of cash!

'As long as you don't do that and as long as you learn from all the other mistakes, then you'll generally be all right', he says.

So what about a role for policy and government in stimulating innovative start-ups like VioCorp? In Ian's view, 'We definitely benefitted from the government's R&D tax program. We would not have survived without that'.

IPhone Viocorp player

Defence force promotional video

2.4.2 Intangible capital investment

Intangible capital includes assets such as data, software, designs, new organisational processes, management quality, R&D, patented technology, reputation (brand equity) and firm-specific skills. Investment in intangibles is a broad proxy measure for investment in innovation-related activities. Business investment in intangible capital has been increasing faster than investment in physical capital in many OECD countries, including Australia.[114] In many developed countries, annual business investment in intangible capital rivals or exceeds investment in physical capital.[115] This is not the case in Australia. Australia's annual investment in intangible assets is low compared to other innovation-driven countries (Figure 2.9). The ratio of intangible capital investment to physical capital investment was 42% in Australia in 2010. This compares poorly with the US at 200% and the OECD average of 82% in the same year.

114 Barnes P & McClure A (2009) *Investments in intangible assets and Australia's productivity growth*, staff working paper, Productivity Commission, Canberra.

115 OECD (2013) *Supporting investment in knowledge capital, growth and innovation*, OECD Publishing, p. 65.

Intangible capital stock accumulation in Australia is also well behind other advanced economies, with Australia's relative total intangible capital stock as a percentage of GDP being around half that of the US. Australia's growth rate in intangible capital stock is about one-quarter that of the OECD average between 1995 and 2010 (Figure A.7).

Figure 2.9 Investment in intangible capital by country, 2010

Note: For Canada, Japan and Korea, estimates refer to 2008.

Source: Statistics on knowledge-based investment based on INTAN-Invest Database (www.intan-invest.net) and national estimates by researchers. Estimates of physical investment are based on OECD Annual National Accounts (SNA) and INTAN-Invest Database, May 2013.

2.4.3 Trends in business innovation

The latest ABS data show that 42.2% of all Australian businesses (approximately 770,000 businesses) were innovation-active in 2012–13 (Table 2.1). This represents a decrease of 2.4 percentage points compared to 2011–12 when Australia reached a maximum value on this indicator at 46.6%. The latest figures indicate decreases in all categories of innovation: goods or services, operational processes, organisational/managerial processes, and marketing methods (Table 2.1).

Historical data for this indicator show a pattern of fluctuation between 37% and 46% since 2005–06. The proportion of innovation-active firms in Australia shows a marginally positive trend since 2006–07, even with the addition of the less-innovative agriculture, fisheries and forestry sector in 2009–10 (Table 2.1).

When you're in the software service game you can't stop [investing in R&D]. We could be vastly profitable and go and get rid of all our engineers, but then we would only around for about 2 years.

—Ian Gardiner, Viocorp

Innovation varies by sector in Australia, from as low as 28.3% in transport, postal and warehousing to 53% in wholesale trade (see also Table 2.2).[116] Sectors that were more than double the industry average (39.1%) were beverage and tobacco product manufacturing; pulp, paper and converted paper product manufacturing; petroleum and coal product manufacturing; basic chemical and chemical product manufacturing; polymer product and rubber product manufacturing; gas supply; rail transport; and residential care and social assistance services (Table 1.2). Hospitals also showed high-innovation performance.

2.4.4 International comparisons of Australian business innovation

Broad international comparisons of innovation by sector are limited by a lack of finely disaggregated data. The ABS and other national statistical agencies do not collect sufficient surveys of businesses to allow reliable subsectoral averages, and are no longer able to provide sectoral data on innovation novelty. For example, although we may know what proportion of businesses in the manufacturing division are innovation-active, we can't tell how innovative large businesses in basic chemical manufacturing are, or how novel those innovations are relative to other countries. Limited country by sector innovation data are presented below.

Most OECD countries collect three-year aggregates of business innovation activity, while Australia reports annual data. The likely consequence is that Australia's innovation performance will appear lower compared to other OECD countries, such as seen in Figure 2.10. ABS analysis suggests this is not a significant effect;[117] however, other studies using a similar definition of innovation show a much higher proportion of businesses innovating.[118] We believe that this requires further investigation.

Australia businesses show variable performance on innovation and related indicators compared to other OECD countries (Table 2.1).

Australian SMEs are highly innovative by OECD standards, ranked 5th out of 29 OECD countries (Figure 2.10).[119] This is a positive result for innovation-driven domestic competitiveness, given that SMEs account for 56% of industry value added. However, SMEs account for only 34% of investment in R&D and approximately 5% of direct exports. In contrast, our 4000 largest firms, which account for 66% of investment in R&D, 44% of industry value

116 ABS (2014) *Innovation in Australian business, 2013–14*, cat. no. 8158.0, ABS, Canberra.

117 Unpublished analysis by the ABS.

118 Verreyenne MS & Steen J (2014) *Queensland Business Innovation Survey 2014 Report,* University of Queensland Business School, Department of Science, Information Technology, Innovation and the Arts, Queensland Government.

119 The OECD uses different size classes—SMEs are 10–249 employees and large firms are more than 250 employees. The OECD also uses an international industry classification that differs slightly from the Australian classification. Unless otherwise noted, where Australia is compared with other countries, the OECD definitions and classifications are used.

added and around 95% of exports, are relatively poorly ranked at 21st out of 29 OECD countries (Figure 2.10).[120]

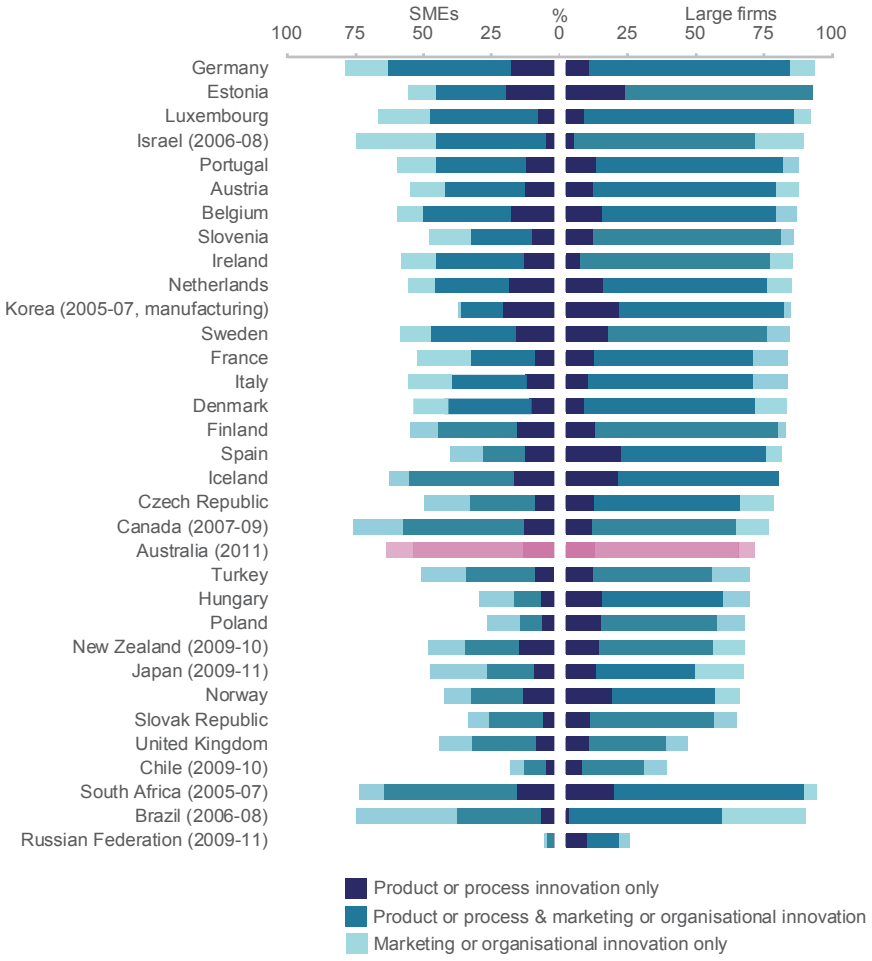
Australian manufacturing is ranked 4th in the OECD on the proportion of innovative businesses (Figure A.8). It is important to remember that cross-country and cross-sectoral comparisons typically involve comparing averages for a sector. The high proportion of SME innovation (Figure 2.10) translates into the relatively highly ranked manufacturing and service sectors innovation because Australian averages are dominated by SME results. Previous analysis shows that small and medium-sized Australian manufacturers have relatively high levels of innovation (ranked 2nd and 5th) compared with their EU counterparts (see Box 2.4 for a case study).

Large Australian manufacturers, by contrast, ranked 20th against 30 EU countries. The large proportion of SMEs in manufacturing in Australia may be a barrier to the development of innovative projects as they struggle to fund R&D.[121] Figure A.8 does not immediately suggest this as a major impediment to innovation per se. However, this depends on your perspective of innovation. More collaborative, new-to-market innovation may drive more participation in global value chains where, in general, Australian manufacturing rates poorly by OECD standards.

120 The Australian performance on this indicator would be expected to be even better than what is presented because Australian data are for only one year compared to a three-year period for most other OECD countries. Value added data comes from ABS (2014) *Australian industry, 2013–14*, cat. no. 8155.0, ABS, Canberra; export data comes from ABS (2014) *Characteristics of Australian exporters*, 2013–14, cat. no. 5368.0, ABS, Canberra.

121 AWPA (2014) *Manufacturing workforce study*, p. 61, www.awpa.gov.au/our-work/sector-specific-skill-needs/Manufacturing_workforce_study/Pages/default.aspx.

Figure 2.10 Innovation types by firm size, 2008–10



Notes: For Australia, data refer to financial year 2010–11 and include product, process, marketing and organisational innovative firms (including ongoing or abandoned innovation activities). See Source for additional country notes.

Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013.

Box 2.4 Case study: Planet Innovation[122]

Planet Innovation

Many companies excel in producing great designs and technically proficient products. But for products to enjoy value creation and growth, they need to be attuned to real world market needs. That is essentially the value proposition behind

122 Based on interview conducted on 12 June 2014.

Planet Innovation, which topped Business Review Weekly's list of Australia's most innovative companies in 2013.

The two mindsets of developing innovative designs and achieving commercial success might seem complementary. But this is not always the case.

'Research expertise does not translate well into commercial expertise', says PI Managing Director Stuart Elliott. 'Commercialisation is a very complex process that requires a lot of expertise that usually is underestimated … The government needs to pay more attention to the commercialisation aspect'.

Formed recently in 2009, Planet Innovation prides itself on being able to skilfully juggle these two worlds. This means successfully translating technical creativity into the commercial world and understanding the end game for both developers and for their customers.

Stuart Elliott, Co-founder and
Managing Director of Planet Innovation

According to Stuart, 'Research is actually only one small piece of the pie. Research doesn't give you products. It gives you knowledge and intellectual property. Success in the commercial world through applied innovation essentially validates the initial idea because that is where the effects and gains from the innovation become apparent'.

Stuart realised early on that entrepreneurs often behave differently from consultants. The ability to think like an entrepreneur while providing consulting services to them helps to drive the company. Planet Innovation's business model therefore reinforces the old adage that the best innovation is one that occurs closest to the customer.

Planet Innovation has been able to assist its clients develop ground-breaking real-world solutions in the highly internationally competitive realms of biotechnology, medical devices, clean tech and other technology fields. It does this by providing what it describes as 'strategic innovation', advanced product development and commercialisation services to leading and emerging biomedical and high-tech companies.

There are opportunities to innovate at every stage of this process. Planet Innovation's approach encompasses a whole-of-product perspective. For instance, it examines how the product fits into a broader ecosystem and how can it have a positive impact on the world.

The company also employs a dedicated innovation manager, who instils innovative and entrepreneurial thinking across the organisation, whether in terms of organisational processes or product offerings. The innovation manager has the ability to bring multidisciplinary and cross-industry perspectives that accelerate the development of new, fast-to-market products. The innovative approach extends to income generation for Planet Innovation itself, with clients able to choose a pure fee-for-service model or for Product Innovation to acquire skin-in-the-game through equity purchase in the client's product.

In the space of its relatively short five-year history, Planet Innovation has worked on more than 80 projects and grown to more than 100 staff. Planet Innovation's services are global in nature and it expanded from its base in Melbourne to open a new office in Chicago in 2013. Further expansion to Europe is planned. This growth shows how niche high-tech design companies can bring Australian innovation—and the export incomes that flow with it—to the world.

Planet Innovation designs and manufactures innovative new devices for the global market

We don't stand still. We continue to innovate and continue to evolve and change and look for new opportunities.

—Michael Drummond, Di Bella Coffee

A similar business-size association can be found for Australian service sector innovation as for manufacturing innovation. Australian service sector businesses ranked 7th out of 28 OECD countries on innovation. Similar to large manufacturers, large Australian service firms do not appear to be as innovative as their EU counterparts. The results are much more variable between service sectors. The transport, postal and warehousing sector, despite having the lowest proportion of innovators in Australia, appears to be quite innovative by EU standards across all firm sizes. Large firms in this sector ranked 14th against their EU counterparts.[123]

SMEs in the financial and insurance services sector have a high relative ranking (4th) against their EU counterparts. By contrast, large firms in this sector had a low relative EU ranking (22nd out of 31 countries). Absolute percentages of innovation for large Australian firms providing financial and insurance services are high and not far below the EU average.[124] In this case, a difference of a few percentage points on innovation can make a big difference in rankings but probably means very little in practice.

Other sectoral cross-country comparisons on innovation such as for mining are harder to come by, because they are not covered by OECD analyses. Even so, mining, and agriculture, fisheries and forestry are sectors that we would expect to perform relatively well against other countries on innovation given the high share of world exports, and high levels of R&D investment and patenting in these sectors. The EU mining sector comparisons

123 AWPA (2014) *Manufacturing workforce study*, p. 61, www.awpa.gov.au/our-work/sector-specific-skill-needs/Manufacturing_workforce_study/Pages/default.aspx

124 Ibid.

introduced in the Australian Innovation System Report 2013 were limited due to a small number of countries, but did show that the Australian mining sector was very innovative by EU standards across all firm sizes.

2.4.5 A select comparison between Australian and American innovators

One criticism of OECD international comparisons is that it does not include one of the most significant technological leaders in the world, the US. Similar to the emphasis placed on the US as a leader on global competitiveness by the recent McKinsey report,[125] we compared Australia and US innovation levels across all sectors except agriculture, fisheries and forestry (Figure A.10). These results are indicative only, because there are differences in industry classifications between the US and Australia. It is also important to remember that Australia's level of innovation relative to the US is not necessarily indicative of global leadership, because other OECD countries appear to perform better than the US and Australia on innovation, particularly new-to-market innovation.

In 2010, Australian businesses were, on average, more innovative than their US counterparts for both product (Figure A.10A; goods and services) and process innovation (Figure A.10B). There is significant sectoral variation in this result. The Australian mining sector is around twice as innovative on process innovation compared with their US counterparts. Many of the Australian service sector firms are significantly more innovative than their US counterparts in both product and process innovation. There do not appear to be significant differences between the US and Australia for the manufacturing; transport, postal and warehousing; and information, media and telecommunications sectors.

2.4.6 Trends in intellectual property protection

Innovation is often in the business model … I used to innovate products and now I innovate business deals. No two are the same.

—Stuart Elliott, Planet Innovation

Intellectual property (IP) protection is an intermediate output measure of innovation, signalling the creation of more novel innovations. Innovative exporters are almost twice as likely to invest in IP as domestic innovators (see Appendix B), and there is generally a high correlation between patenting and trademarking strengths, and the international competitiveness of a sector (Chapter 3). Not all IP protection is registered. Soames et al. (2011) found that, across the entire economy, there is a strong association between some forms of IP protection and a high degree of innovation novelty. Australian firms that use complexity of design to protect the IP of their innovation were 204% more likely to be introducing new-to-world innovations. Businesses that were registering designs or using secrecy/confidentiality agreements were 129% and 92% more likely to be introducing new-to-world innovation, respectively.[126] Interestingly, neither patents nor

125 AWPA (2014) *Manufacturing workforce study*, p. 61, www.awpa.gov.au/our-work/sector-specific-skill-needs/Manufacturing_workforce_study/Pages/default.aspx.

126 Soames L et al. (2011) *Competition, innovation and productivity in Australian businesses*, research paper, Productivity Commission and Australian Bureau of Statistics, cat. no. 1351.0.55.035, Canberra.

trademarks appeared to have a significant association with innovation novelty; however, this economy-wide study did not disaggregate results by industry. Manufacturing uses patents, but many service sectors do not.

Data on the latest IP indicators for Australia show declining aggregate performance (Table 2.1). Absolute numbers of IP outputs such as patents, industrial designs and trademarks all showed a decrease in 2013. The decrease was particularly sharp in industrial designs, as the number certified by IP Australia dropped by 32% (from 318 to 217), reversing a positive trend since 2005. International comparisons of IP outputs such as Patent Cooperation Treaty resident applications per billion of GDP ($ purchasing power parity [PPP]), National Office resident trademark registrations per billion of GDP ($PPP) and Madrid-system trademark registrations show that Australia is within the lower-middle range of the OECD (Table 2.1).

Be a market leader rather than follower. A big advantage comes from early market entry.

—Anton Pemmer, Bottles of Australia

2.5 Barriers to the performance of the innovation system

There is a large body of recent reports that shows the importance of innovation in lifting Australia's competitiveness by achieving business goals of quality, cost and delivery performance. Despite this evidence, Australian businesses tend to downgrade innovation as a priority[127] and there is a relatively poor culture of innovation in Australian industry.[128] For example, a recent survey[129] found that almost half (44.8%) of businesses surveyed had no specific person or group responsible for innovation within their organisation. A large proportion of respondents to the same survey did not know how much their organisation spent on innovation, technology upgrades or training. This poor culture and low awareness of innovation strategy, in association with an average to poor management performance, has been argued to explain Australia's moderate to low performance on innovation, particularly collaborative world-first innovation. The literature (see Box 2.5) finds that the main impediments to the innovation system are:

- poor networking and collaboration
- poor levels of venture and private equity capital investment in innovation
- some fragmented and/or obstructive government policies or regulations such as tax treatment of employee share schemes, government procurement of innovation and low incentives for research commercialisation/collaboration in the public research sector

127 Samson D & Gloet M (2013) *Innovation: the new imperative*, University of Melbourne and the Australian Institute of Management.

128 Microsoft Australia (2014) *Joined up innovation, discussion paper*, www.microsoft.com/enterprise/en-au/business-leaders/joined-up-innovation/default.aspx#fbid=XM_Qg-4JxGn; Samson D & Gloet M (2013) *Innovation: the new imperative*, Australian Institute of Management and University of Melbourne, www.aim.com.au/sites/default/files/AIM_InnovationTheNewImperative.pdf.

129 Samson D & Gloet M (2013) *Innovation: the new imperative*, Australian Institute of Management and University of Melbourne, www.aim.com.au/sites/default/files/AIM_InnovationTheNewImperative.pdf.

- a small geographically isolated economy dominated by small businesses and/or lifestyle entrepreneurs that are seeking local competitive advantage through cost reduction rather than pushing the innovation frontier to capture world markets through value creation
- poor business culture of innovation and risk aversion in Australia, exacerbated by an ageing population[130]
- relatively poor business management capability and underinvestment in innovation and related activities.

Box 2.5 Recent reviews of innovation, competitiveness and the innovation system

Innovation and Business Skills Australia's 2011 Karpin report revisited: Leadership and management challenges in Australia report

www.ibsa.org.au/sites/default/files/media/Karpin%20Revisited,%20Leadership%20and%20Management%20Challenges%20in%20Australia.pdf

Deloitte's 2012 Silicon Beach report

www2.deloitte.com/au/en/pages/technology-media-and-telecommunications/articles/silicon-beach-study-australian-startup-ecosystem.html

CPA Australia's 2013 Australia's Competitiveness report

www.cpaaustralia.com.au/professional-resources/business-management/australias-competitiveness

Price Waterhouse Coopers 2013 Digital pulse report

www.digitalpulse.pwc.com.au/wp-content/uploads/2013/04/PwC-Google-The-startup-economy-2013.pdf

The B20 2014 Human capital taskforce report

www.b20australia.info/Documents/B20%20Human%20Capital%20Taskforce%20Report.pdf

StartupAUS's 2014 Crossroads report

startupaus.org/crossroads/

Microsoft Australia's 2014 Joined-up innovation report

www.microsoft.com/enterprise/en-au/business-leaders/joined-up-innovation/default.aspx#fbid=wJvAxgvJLXx

Australian Council of Learned Academies' 2014 The role of science, research and technology in lifting Australian productivity report

www.acola.org.au/index.php/projects/securing-australia-s-future/project-4;

The Business Council of Australia's 2014 Building Australian Innovation System report

www.bca.com.au/publications/building-australias-innovation-system

130 There is evidence that older people tend to be less willing to take on risks, including those associated with new business ventures, developing new products and services, and pursuing innovation more generally. See evidence and references presented in Kent C (2014) *Ageing and Australia's economic outlook,* address to the Leading Age Services Australia (LASA) National Congress, Adelaide, 20 October 2014.

Deloitte Access Economics 2014 report for the Business Council of Australia, Australia's innovation imperative

www.bca.com.au/publications/building-australias-innovation-system

See also the many other submissions to the recent Senate Inquiry into Australia's Innovation System

www.aph.gov.au/Parliamentary_Business/Committees/Senate/Economics/Innovation_System/Submissions

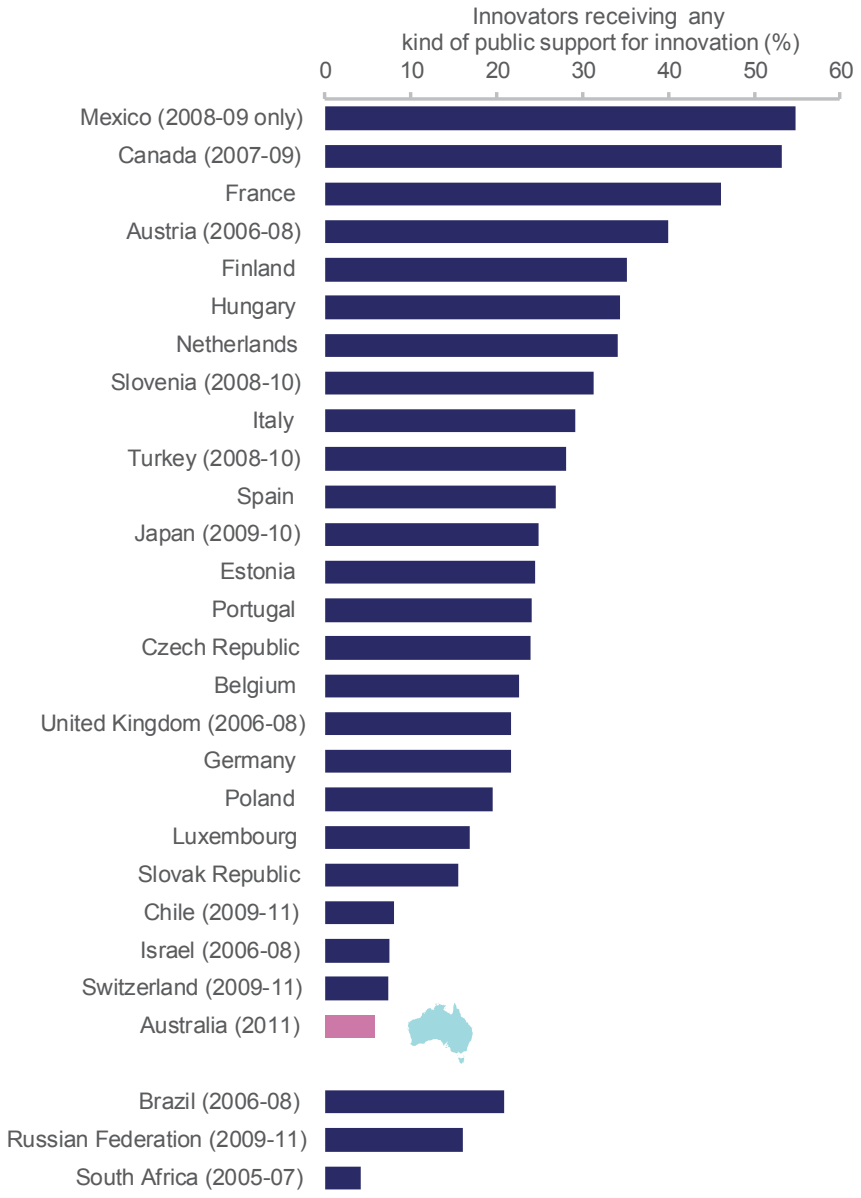
According to the OECD, decisions on innovation investment are largely the responsibility of the private sector. The role for governments is to support business investment decisions by providing a stable policy environment where market or system failures can be identified and addressed through market interventions that unlock the rate and scale of innovation. Typically, the public good aspects of innovation are used as a general argument for policy intervention.[131] However, the scale of direct government influence is currently low in Australia.

Of the approximately 770,000 innovation-active businesses in 2012–13, 3% received financial assistance from Australian, and state and territory governments for the development or introduction of innovation.[132] The level of public sector assistance to innovating firms between 2008 and 2010 was the lowest in the OECD, ranked 25th out of 25 OECD countries measured (Figure 2.11).

131 Productivity Commission (2007) *Public support for science and innovation*, www.pc.gov.au/__data/assets/pdf_file/0014/37121/scienceoverview.pdf.

132 ABS (2014) *Innovation in Australian business, 2013–14,* cat. no. 8158.0, ABS, Canberra.

Figure 2.11 Firms receiving public support for innovation, 2008–10



Notes: For Australia, data refer to financial year 2010–11 and include product, process, marketing and organisational innovative firms (including ongoing or abandoned innovation activities). See source for additional country notes.

Source: OECD based on Eurostat (CIS-2010) and national data sources, June 2013.

What is not often understood or recognised is the massive complementary investment in innovation that Australian governments make indirectly through framework conditions such as infrastructure, research, education, health, industry standards, corporate governance and regulatory environments. Private and public sector investment in R&D in Australia tend to complement each other across different socioeconomic objectives (Figure A.11). The majority of private R&D investment is applied research and experimental development, with basic and applied research support from government.

Commercialisation is a very complex process that requires a lot of expertise that usually is underestimated … The government needs to pay more attention to the commercialisation aspect.

—Stuart Elliott, Planet Innovation

In the health sector, there is a more balanced split of R&D investment between private and public sector investment (Figure A.11).

2.5.1 Business innovation management

Strong management and leadership is a common thread connecting all the themes of innovation investment and performance, collaboration and capability building detailed in this report. Strong management and leadership skills are correlated with increased innovation and productivity, as well as overall increased employee engagement, satisfaction and wellbeing.[133] Innovation management is critical to business competitiveness.[134] Recent empirical work by Bloom et al. (2014)[135] suggests that one-quarter of cross-country and within-country multifactor productivity gaps can be accounted for by management practices.[136]

There has been a resurgence of attention paid to management capability in Australian manufacturing, beginning with Roy Green's report, funded by the Australian Government Department of Industry, in 2009.[137] Management performance in the manufacturing sector was above average, but lags behind the top performers, particularly in people management, and may partly explain our generally low degree of international competitiveness in the sector.

This issue has been recognised by policy makers through mentoring and support programs such as Enterprise Connect and Commercialisation Australia, now replaced by the Entrepreneur's Infrastructure Programme.[138] Data from the Enterprise Connect Program business reviews undertaken by business advisers identified that 85% of the applicants had weaknesses in management areas such as strategic business activities.

More recent management capability studies with a broader sectoral coverage also show similar results. Three-quarters of respondents to a recent poll by the Australian Centre for Workplace Leadership agreed

133 Bloom N & van Reenen J (2010) Why do management practices differ across firms and countries? *Journal of Economic Perspectives* 24(1):203–24; Green R (2009) *Management matters in Australia: just how productive are we?* worldmanagementsurvey.org/wp-content/images/2010/07/Report_Management-Matters-in-Australia-just-how-productive-are-we.pdf; and Boedker C et al. (2011) *Leadership, culture and management practices of high-performing workplaces in Australia: the high-performing workplaces index*. Society of Knowledge Economics, Sydney.

134 Dodgson M (2014) Collaboration and innovation management, in: Dodgson et al. (eds), *The Oxford handbook of innovation management*, Oxford University Press, Oxford; and Palangkaraya A et al. (2014) *Is science-based innovation more productive? A firms level study*, report to the Australian Council of Learned Academies www.acola.org.au/index.php/the-role-of-science-research-and-technology-in-lifting-australian-productivity-contributing-reports.

135 Bloom N et al. (2014) *The new empirical economics of management*, NBER Working Paper 20102.

136 In this case, multifactor productivity gaps are the proportion of total output growth of an economy that cannot be accounted for by growth in labour and capital inputs (see Chapter 1). Management practices relating to innovation are excluded from this analysis.

137 Green R (2009) *Management matters in Australia: Just how productive are we?* worldmanagementsurvey.org/wp-content/images/2010/07/Report_Management-Matters-in-Australia-just-how-productive-are-we.pdf

138 www.business.gov.au/advice-and-support/EIP/Pages/default.aspx.

that Australian workplaces need better management and leadership.[139] Australian management capability is slipping according to the 2014 Australian Management Capability Index and is particularly low in innovation and management's international perspective and understanding of global markets and global thinking.[140] The same report shows that Australian management capability is low compared with other countries in our region.[141]

We can also use the adoption of international standards for quality management and environmental management[142] as a proxy for comparing Australian management standards to the rest of the world. Australia had 9.6 ISO9001 management quality certificates per billion $PPP GDP, which puts Australia 49th out of 143 countries.[143] Australia had 2.1 ISO14001 environmental certificates per billion $PPP GDP, ranking Australia 47th out of 143 countries.[144]

Recent research by McKinsey & Co shows that average Australian large business management performance is characterised by low levels of both innovation and learning, and external orientation. Similar to the results of Green (2009), McKinsey found that large Australian businesses are not consistently capturing the value of innovation because of average implementation capabilities. Although similar to many other countries on average, Australia has very few strong performers on implementation.[145] This result may explain why the innovation performance of large firms is generally poor and why our ranking in the efficiency of our innovation system is apparently so low. Recent innovation and competitiveness reviews have identified specific areas where Australian managers and leaders can focus their attention:

- develop a unique understanding of local and foreign customers, suppliers and competitors, and redesign globally oriented business models to both account for those needs and lower costs
- develop systems, processes and skills that identify international opportunities; overcome cultural barriers; and improve negotiation, planning and risk management
- build and maintain a network of partnerships with businesses and other organisations that can collectively
    - learn from mistakes, solve problems and realise new opportunities

139 Australian Centre for Workplace Leadership (2014) *Australian workplace leadership poll,* newsroom.melbourne.edu/cwl-survey-results.

140 Australian Institute of Management (2014) *Australian Management Capability Index 2014*, www.aim.com.au/sites/default/files/ACMI2014_FullReport.pdf.

141 New Zealand, Hong Kong, India, Malaysia and Singapore.

142 www.iso.org/iso/iso_9000; www.iso.org/iso/iso14000

143 Cornell University, INSEAD & WIPO (2014) T*he Global Innovation Index, 2014: the human factor in innovation*, Fontainebleau, Ithaca and Geneva, p. 145.

144 Ibid.

145 Lydon J et al. (2014) *Compete to prosper: Improving Australia's global competitiveness*, McKinsey Australia.

- build understanding and excellence around the management of intangible assets such as skills
- build a culture of collaborative innovation
- build critical market scale or degree of diversification

► develop a small, manageable portfolio of high-priority innovation initiatives with full ownership and commitment from senior leaders.[146]

Box 2.6 Case study: Di Bella Coffee

From humble beginnings as a small coffee-roasting business in Brisbane in 2002, Di Bella Coffee is now the largest specialty coffee producer in Australia, with an 11% market share and a turnover of more than $23 million per year. Manufacturing in the form of coffee roasting is done in founder Phil Di Bella's home town of Brisbane, but there are also roasting warehouses in Melbourne, Sydney and Fremantle. Di Bella Coffee is predominantly a business-to-business operation supplying, around 1200 cafes in Australia.

Di Bella Coffee's Director of Corporate Services Michael Drummond explains the company's basic approach. 'From day one (Di Bella Coffee founder) Phil Di Bella built a brand around the concept that it's not just about a product. It's not just about a bag of beans. There are so many other things that come with that—leading authority, education, the ultimate coffee experience.'

Di Bella Coffee delivers to the customer the full experience that Australians have now come to expect from their coffee. This is not just great-tasting coffee and quality service, but also an ethical and innovative approach to managing their global supply chain.

For instance, to distinguish itself from the competition, Di Bella Coffee prides itself on being the only coffee company in Australia to deal 100% directly with the farmer, with a focus on supporting ethical and sustainable farming practices. Part of this approach is developing a direct relationship with the farmer. For instance, Di Bella Coffee guarantees it will buy 12 months worth of product to give the farmers income certainty, which in turn empowers them to innovate and improve Di Bella Coffee products. Di Bella Coffee also picks up 'real time' information on seasonal and environmental changes that helps the company avoid price shocks and maintain consistent, quality product.

Michael Drummond offers many insights into how Di Bella Coffee established itself in such a competitive industry. 'A core part of being successful is being able to make that connection with your audience or your consumer, and maintaining that

146 Ibid.; and ACOLA (2014) *The role of science, research and technology in lifting Australian productivity*, Securing Australia's future Project 4 final report, www.acola.org.au

connection,' says Michael. 'There's got to be a personal and emotional connection. The best way to do that is through the brand.'

One of the ways that the company connects with its customers is to educate them so that they understand the coffee business from crop to cup. They get the full coffee experience, plus the added benefit of a rundown on what makes a great cup of coffee and where it comes from. 'Our current customers then become some of our best sales people,' says Michael.

Sack with crop to cup logo

In 2013, Di Bella Coffee was listed by the Business Review Weekly as one of Australia's most innovative businesses for its development of the TORQ liquid instant coffee. TORQ has provided a better coffee experience to the volume-based corporate market, and to regional and remote communities. Di Bella Coffee continues to experiment with new product, process and organisational innovations. For example, in the past two years, the company has invested $2 million adapting a new, computer-controlled silo technology from the grains industry into their roasting warehouse.

Michael explains the benefits. 'We can double our output of beans and we don't need to put any more staff on because everything can be remotely operated'.

The adapted technology also created workplace health and safety, and quality-control benefits, because roasting can all be done without human intervention and contamination. Silos were also important for protecting the secret recipes behind the Di Bella Coffee blends.

When asked how much of their market share came from innovation, Michael said, 'innovation as we see it is intrinsically linked to education and awareness, and intrinsically linked to our brand. On one hand it's 100% linked to innovation because our growth is based on sharing our knowledge with the consumer. So when we develop something new or improve something we're bringing the consumer along for the journey and, as a result, the market growth comes from that relationship based on education'.

So confident of its ability to offer something unique to the coffee-drinking community, Di Bella Coffee has embarked full swing into the still underdeveloped tea-dominated Asian markets. It opened in Shanghai in 2010 and even ventured into India in 2011. This includes opening coffee training institutes and developing licensing arrangements through local partners rather than exporting large quantities of beans to those markets. In 2013, Di Bella Coffee New Zealand was established. Di Bella Coffee now exports to New Zealand, China, India, the United States,

Singapore and the United Arab Emirates through partners that share their business philosophy.

Michael explains, ‘we’re driving everything through brand. To preserve and protect our brand we can really only partner with people that we know can protect it … people that are aligned with our philosophy’.

Di Bella Coffee’s growth and development shows that innovation and the competitiveness that comes with it is not always just about creating great products. It’s about branding the whole experience and taking your customer along for the journey.

Di Bella roasting

Be a market leader rather than follower. A big advantage comes from early market entry.

—Anton Pemmer, Bottles of Australia

Table 2.1 Indicators of Australia's innovation and entrepreneurship activity

Australian Trend Data (i)											OECD Comparisons				
Indicators	1995	2000	2005	2007	2008	2009	2010	2011	2012	2013	Australia's score (ii)	OECD average (iii)	OECD top 5 average (iv)	Gap from the top 5 OECD performers (%) (v)	Ranking against OECD countries (vi)
Intangible capital stock, AU$ billion [1] [a]	141.5	180.1	223.6	248.6	260.4	270.8	279.5	288.3	297.4	–	–	–	–	–	–
Intangible capital stock, % of GDP [2]	16.6	18.0	17.8	18.0	18.3	18.5	18.4	–	–	–	18.4	25.6	31.9	42	14
BERD, % of GDP [3]	0.82	0.71	1.05	1.28	1.37	1.29	1.28	1.23	–	–	1.23	1.29	2.81	56	15
Percentage of BERD financed by government, % [3]	2.4	3.8	4.0	2.8	2.0	2.0	1.7	1.9	–	–	1.9	7.8	14.6	87	31
Proportion of innovation-active businesses in Australia, % [4] [b]	–	–	37.1	44.9	39.8	43.8	39.1	46.6	42.2	–	–	–	–	–	–
Proportion of innovation-active SMEs (0–199 persons), % [5] [b]	–	–	36.7	44.8	39.7	43.7	38.9	46.6	42.0	–	63.8	51.9	71.9	11	5
Proportion of innovation-active large firms (200 or more persons), % [4] [b]	–	–	66.2	70.8	66.7	74.3	65.9	76.0	74.3	–	71.9	78.0	91.2	21	21
Proportion of businesses introducing goods or services innovation, % [6]	–	–	19.3	21.9	18.2	19.8	17.3	20.4	20.2	–	–	–	–	–	–
Proportion of businesses introducing operational/process innovation, % [6]	–	–	20.8	17.6	16.3	16.9	16.4	19.1	16.9	–	–	–	–	–	–
Proportion of businesses introducing organisational/managerial process innovation, % [6]	–	–	20.7	19.0	19.4	20.7	18.9	23.0	20.2	–	–	–	–	–	–
Proportion of businesses introducing marketing innovation, % [6]	–	–	14.3	14.6	17.2	16.7	16.8	19.9	18.8	–	–	–	–	–	–
Proportion of innovation-active businesses innovating to reduce environmental impacts, % [7] [b]	–	–	12.1		11.4		12.9		11.7	–	–	–	–	–	–
Share of high- and medium–high-technology manufacturing, % of GDP [8] [b]	–	–	2.37	2.31	2.19	2.00	1.96	1.93	1.82	–	1.82	7.3	11.5	84	15
Employer Enterprise Birth Rate, % [9] [c]	–	–	16.3	15.3	14.4	16.7	13.9	13.5	11.2	–	17.1	11.1	14.3	no gap	1
Total early-stage entrepreneurship activity (TEA), % [10] [l] [m]	–	14.7	10.5	–	–	–	7.8	10.5	–	–	10.5	8.2	14.5	28	5
Employer Enterprise Death Rate, % [11] [e]	–	–	15.0	15.3	15.4	13.1	13.5	13.1	14.1	–	–	–	–	–	–
Churn Rate, % [11] [d]	–	–	1.3	–0.1	–1.0	3.6	0.4	0.4	–2.9	–	–	–	–	–	–
1-year survival rate (employer enterprises), % [11]	–	–	85	84.7	84.6	86.9	86.5	86.9	85.9	–	–	–	–	–	–
Patents granted by IP Australia, for Australian residents [12] [b] [g]	–	–	924	1,086	925	926	1,178	1,262	1,311	1,110	–	–	–	–	–
Innovation Patents by Australian residents [12] [h]	–	–	926	1,034	1,028	1,109	1,127	1,204	1,205	1,131	–	–	–	–	–
Industrial designs certified by IP Australia, for Australian residents [12] [i]	–	–	115	238	342	274	327	265	318	217	–	–	–	–	–
Triadic patent families per million population [3]	13.0	19.8	13.1	10.9	10.8	10.3	9.0	9.1	8.5	–	8.5	24	74.9	89	21
Patent applications filed by Australian residents under Patent Cooperation Treaty (PCT) per million population [12] [b] [j]	–	–	96	97	90	79	79	77	75	69	–	–	–	–	–

Australian Trend Data (i)											OECD Comparisons				
Indicators	1995	2000	2005	2007	2008	2009	2010	2011	2012	2013	Australia's score (ii)	OECD average (iii)	OECD top 5 average (iv)	Gap from the top 5 OECD performers (%) (v)	Ranking against OECD countries (vi)
Share of world triadic patent families, % [3]	0.7	0.8	0.6	0.5	0.6	0.6	0.5	0.5	0.5	–	0.5	2.8	16.1	97	17
Patent applications filed under PCT per million population [12]	46	91	102	95	85	84	78	78	71	–	71	114	300	76	20
Green Patents, Index 1990=100 [13]	205	339	546	653	655	661	460	–	–	–	460	1,638	4,538	90	19
Madrid-system trademark registrations by country of origin, per billion PPP$ GDP [14]	–	–	–	–	–	–	–	–	–	16.3	16.3	28	72.2	77	18
PCT resident applications, per billion PPP$ GDP [14]	–	–	–	–	–	–	–	–	–	31.5	31.5	38.6	73.8	57	22
Industrial design registrations (Australian resident) per million population, [12 (k)]	121	98	136	110	113	119	111	111	107	125	–	–	–	–	–
Trademark applications from Australian residents [12]	19,036	27,175	38,193	40,001	38,381	38,466	39,633	40,056	41,106	39,663	–	–	–	–	–
Trademark registrations (Australian resident) per million population [12 (k)]	429	504	1,091	1,221	1,245	1,123	1,077	1,062	1,063	1,069	–	–	–	–	–
National Office resident trademark registrations, per billion PPP$ GDP [14]	–	–	–	–	–	–	–	–	–	26	26	27	56.2	54	17

– = data not available

Table notes: (i) Data are presented in calendar year format. Where the data are in financial years, it is expressed in terms of the year where the financial year begins e.g. 2010–11 is shown as 2010. (ii) The 'Australia's score' field presents the Australian values used in the OECD comparisons. (iii) This is the arithmetic (simple) average of the OECD country scores. (iv) This is the arithmetic (simple) average of the top five OECD countries in a ranked list. (v) This represents Australia's distance from the frontier as defined by the average of the top five ranked OECD countries. It is calculated as 100*(Top five average - Australia's score)/ Top 5 average. Where the solution is a negative value or zero, 'no gap' is shown in the cell. (vi) OECD rankings are performed on those OECD countries for which data are available. Individual data availability may vary between indicators.

Indicator notes: Indicator notes: (a) Intangible capital investment includes R&D, Design, Market research & Branding, Organisational improvement, Business-specific training and skills development, Software development, Mineral exploration and Artistic originals. (b) 2006 data used in absence of 2005 data (c) Firm entry rate (%) = 100 x Entries/ Number of businesses operating at the start of the financial year. A business entry event is the registration of a new business for an ABN and the allocation of a GST role, or the allocation of a GST role to an existing ABN which previously did not have this role. (d) Churn rate (%) = 100 x (Entries - Exits)/ Number of businesses operating at the start of the financial year. A business exit event is the cancellation of a business' ABN or GST role and/or when a business ceases to remit GST for at least five consecutive quarters in respect of that ABN (or 3 consecutive years for annual remitters). Thus, a business exit is defined as a business which was actively trading on the business register at 30 June in the previous year but was not actively trading at 30 June in the reference year. (e) Death rate (%) = 100 x Exits/ Number of businesses operating at the start of the financial year. (f) Survival rate (%) = 100 - Death rate (%). (g) IP Australia's databases country codes are not complete for mainframe applications. As a result, the number of Australian grants may be understated prior to 2008. (h) The innovation patent regime was established in November 2000, and as such the first full year of data available is 2001. (i) Design Certification was introduced with the 2003 Act, so no observations before then. (j) PCT data are not currently available prior to 2006. (k) The population data has been sourced from ABS (2013) Australian Demographic Statistics, Dec 2012, cat. no. 3101.0. (l) TEA (%) is defined as the percentage of 18–64 age group who are either a nascent entrepreneur or owner-manager of a new business. A nascent entrepreneur is one that is actively involved in setting up a business they will own or co-own; this business has not paid salaries, wages or any other payments to the owners for more than three months. The owner-manager of a new business is defined as one that has paid salaries, wages or any other payments to the owners for more than three months, but not more than 42 months. (m) 2001 data used in absence of 2000 data.

Sources: [1] ABS (2012) *Australian System of National Accounts*, cat. no. 5204.0; Elnasri A & Fox K (forthcoming) *The Contribution of Research & Innovation to Productivity & Economic Growth*. [2] IntanInvest database, http://intan-invest.net/. Accessed 2014-11-06; Melbourne Institute of Applied Economic and Social Research (2012) Figures commissioned by DIISRTE. [3] OECD (2014) Main Science and Technology Indicators, 2014-1. Accessed 2014-08-13 DOI: 10.1787/2304277x. [4] ABS (various) Summary of IT Use and Innovation in Australian Business, cat. no. 8166.0. URL: http://www.abs.gov.au/ausstats/abs@.nsf/mf/8166.0. [5] ABS (various) Customised report based on the Business Characteristics Survey data commissioned by the Department of Industry [6] ABS (various) Selected Characteristics of Australian Business, cat. no. 8167.0. URL: http://www.abs.gov.au/ausstats/abs@.nsf/mf/8167.0. [7] ABS (various) Innovation in Australian Business, cat. no. 8158.0. URL: http://www.abs.gov.au/ausstats/abs@.nsf/mf/8158.0. [8] ABS (2014) Australian Industry: Manufacturing industry, 2012–13, Table 1, cat. no. 8155.0.; ABS (2014) Australian National Accounts: National Income, Expenditure and Product. September 3, 2014 Table 31, cat. no. 5206.0. Income from GDP and Changes in Inventories, Annual. OECD Comparisons come from OECD STAN database revision 4 [9] ABS (various) Counts of Australian Businesses, including Entries and Exits, cat. no. 8165.0. URL: http://www.abs.gov.au/ausstats/abs@.nsf/mf/8165.0; OECD (2013) Structural and Demographic Business Statistics (SDBS) Database. DOI: 10.1787/sdbs-data-en [10] Global Entrepreneurship Research Association (2014) Global Entrepreneurship Monitor, URL: http://www.gemconsortium.org/. [11] ABS (various) Counts of Australian Businesses, including Entries and Exits, cat. no. 8165.0. URL: http://www.abs.gov.au/ausstats/abs@.nsf/mf/8165.0. [12] Australian Government (2014) Special data request from IP Australia. [13] OECD (2014) Green growth indicators, DOI: 10.1787/data-00686-en [14] Cornell University, INSEAD, WIPO (2013) Global Innovation Index, accessed 2014-03-05 URL: http://www.globalinnovationindex.org.

Table 2.2 Innovation, R&D and other economic activity by sector

ANZSIC 2 digit	Innovation, %[a]	R&D expenditure, $m[b]	R&D intensity, %[b]	Total supply, $m[b]	Exports, $m[b]	Export intensity, %[b]	Domestic intensity, %[b]	Sectoral domestic interdependence, %[b]	Import competition, %[b]
Agriculture	30.4	156	0.65	51,198	7,490	14.6	16.6	68.7	2.1
Aquaculture	n/a	11	2.74	1,034	96	9.3	29.2	61.5	4.8
Forestry and logging	n/a	15	1.24	3,165	115	3.6	7.3	89.1	1.7
Fishing, hunting and trapping	47.8	6	0.92	1,781	422	23.7	22.2	54.1	3.5
Agriculture, forestry and fishing support services	18.6	34	1.56	6,734	746	11.1	7.9	81.0	0.5
Coal mining	60.2	1,045	4.93	36,649	33,304	90.9	0.4	8.7	0.1
Oil and gas extraction	56.1	737	3.20	43,615	16,315	37.4	1.8	60.7	28.4
Metal ore mining	43.5	1,326	3.23	71,196	41,278	58.0	2.9	39.2	10.1
Non-metallic mineral mining and quarrying	50.9	179	9.65	3,205	343	10.7	-6.6	95.9	5.0
Exploration and other mining support services	33.5	1,698	21.04	20,621	10	0.0	28.1	71.9	1.6
Food product manufacturing	51.4	355	2.03	77,952	14,302	18.3	42.7	38.9	12.7
Beverage and tobacco product manufacturing	88.5	22	0.35	20,754	3,599	17.3	45.7	36.9	15.2
Textile, leather, clothing and footwear manufacturing	45.5	44	1.08	20,372	2,149	10.5	51.1	38.4	54.9
Wood product manufacturing	46.9	68	1.61	12,464	966	7.8	-4.6	96.9	11.4
Pulp, paper and converted paper product manufacturing	99.7	84	2.88	12,409	892	7.2	15.9	76.9	26.2
Printing (incl. reprod. recorded media)	34.2	36	0.87	8,608	40	0.5	1.9	97.7	1.5
Petroleum and coal product manufacturing	93.3	153	4.73	42,059	2,786	6.6	24.0	69.4	39.1
Basic chemical and chemical product manufacturing	98.5	726	8.01	50,338	7,005	13.9	32.5	53.6	40.0
Polymer product and rubber product manufacturing	73.0	166	3.22	20,808	904	4.3	13.7	82.0	34.6
Non-metallic mineral product manufacturing	24.6	116	2.36	17,161	313	1.8	-3.8	102.0	13.7
Primary metal and metal product manufacturing	44.5	543	4.52	70,446	33,168	47.1	-0.6	53.5	10.1
Fabricated metal product manufacturing	56.7	161	1.49	31,086	1,070	3.4	8.6	88.0	15.7
Transport equipment manufacturing	57.3	988	10.79	61,611	3,645	5.9	68.5	25.6	53.7
Machinery and equipment manufacturing	47.2	988	8.50	93,109	6,037	6.5	54.7	38.8	63.9
Furniture and other manufacturing	65.6	34	1.24	15,849	1,133	7.2	66.2	26.7	46.2
Electricity supply	70.9	224	1.23	41,042	54	0.1	24.2	75.7	0.0
Gas supply	100.0	27	2.85	13,936	0	0.0	14.3	85.7	0.0
Water supply, sewerage and drainage services	39.1	102	1.33	3,775	11	0.1	48.5	51.4	0.1
Waste collection, treatment and disposal services	45.2	69	2.36	63,660	0	0.0	28.2	71.8	0.0
Building construction	38.3	572	2.46	112,031	125	0.1	99.9	0.0	0.0
Heavy and civil engineering construction	52.4	677	3.34	110,271	0	0.0	89.8	10.2	0.0
Construction services	28.9	166	0.31	104,458	11	0.0	0.1	99.9	0.0

ANZSIC 2 digit	Innovation, %[a]	R&D expenditure, $m[b]	R&D intensity, %[b]	Total supply, $m[b]	Exports, $m[b]	Export intensity, %[b]	Domestic intensity, %[b]	Sectoral domestic interdependence, %[b]	Import competition, %[b]
Wholesale trade	57.1	829	1.48	104,458	9,602	9.2	44.0	46.8	0.0
Retail trade	48.8	83	0.14	78,270	816	1.0	92.0	6.9	0.0
Accommodation	47.8	5	0.07	14,957	5,030	33.6	48.5	17.9	23.4
Food and beverage services	43.4	26	0.11	55,880	2,825	5.1	77.1	17.9	4.5
Road transport	21.9	33	0.17	46,661	8,115	17.4	27.2	55.4	2.4
Rail transport	77.2	21	0.31	12,087	6,003	49.7	30.0	20.4	1.5
Water transport	n/a	9	0.29	8,585	2,217	25.8	26.2	48.0	9.1
Air and space transport	31.3	80	1.17	28,426	n/a	n/a	0.0	25.3	32.5
Postal and courier pick-up and delivery services	18.1	28	0.56	10,656	n/a	n/a	0.0	93.5	0.9
Transport support services and storage	51.7	149	0.66	42,101	2,879	6.8	24.2	68.9	1.5
Publishing (except internet and music publishing)	69.4	188	1.98	21,233	1,230	5.8	35.7	58.5	14.3
Motion picture and sound recording activities	36.5	17	0.75	6,748	276	4.1	43.6	52.3	20.8
Broadcasting (except internet)	41.7	15	0.31	10,038	163	1.6	33.4	65.0	8.1
Internet publishing and broadcasting and services providers, websearch portals and data processing services	76.2	43	1.32	8,943	55	0.6	35.0	64.4	1.1
Telecommunications services	55.2	554	2.72	36,737	683	1.9	35.6	62.5	2.1
Library and other information services		0	0.00	1,746	14	0.8	81.5	17.7	
Finance	44.8	1,497	1.91	97,752	1,078	1.1	29.6	69.3	0.5
Insurance and superannuation funds	39.8	132	0.82	33,694	274	0.8	80.0	19.2	1.4
Auxiliary finance and insurance services	45.2	149	0.51	40,259	199	0.5	5.2	94.3	0.8
Rental and hiring services	46.1	80	1.31	30,137	1,154	3.8	7.3	88.8	13.2
Property operators and real estate services	43.7	122	0.57	68,311	93	0.1	6.5	93.3	0.2
Professional, scientific and technical services	46.1	3,202	5.34	166,100	6,069	3.7	18.7	77.6	3.3
Computer system design and related services	60.9	1,150	5.48	40,621	807	2.0	28.7	69.3	2.1
Administrative services	44.7	966	1.43	130,670	1,397	1.1	53.9	45.0	0.7
Building cleaning, pest control and other support services	30.0	3	0.04	13,719	52	0.4	9.8	89.8	0.2
Health care services	64.9	280	0.62	67,266	349	0.5	97.1	2.4	0.7
Residential care and social assistance services	76.5	173	0.60	39,561	112	0.3	99.5	0.2	0.2
Heritage, creative and performing arts	44.9	9	0.28	7,180	85	1.2	60.6	38.2	1.0
Sports and recreation activities	49.4	45	1.00	13,475	399	3.0	71.3	25.7	2.2
Gambling activities	33.0	26	0.79	6,972	477	6.8	93.2	0.0	5.8
Repair and maintenance	39.1	50	0.44	44,043	77	0.2	17.6	82.3	0.7
Personal and other services	47.0	49	0.30	11,900	160	0.8	86.7	12.5	0.7

Notes: [a] Innovation percentage is an average of innovation-active businesses for 2010–11, 2011–12 and 2012–13 years for two digit ANZSIC industries.

[b] R&D expenditure, R&D intensity, gross value added, export value, export intensity and sectoral interdependence indicators are derived from 2009–10 National Accounts Input Output tables. R&D intensity is the total expenditure on R&D divided by total gross value added. Export intensity is the percentage of total supply that is exported. Domestic intensity represents supply for each sector that is used by final consumption by households and government, gross fixed capital formation and changes in inventories. A negative score in this category represents a significant reduction in inventory. Sectoral interdependence represents the share of total supply for each sector that is an intermediate for production in all other sectors. Import competition is the percentage of total final demand satisfied by competing imports.

Sources: ABS (2013) Australian National Accounts: input–output tables, 2009–10, Table 2; and ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

3. Australia's international competitiveness and engagement

In this chapter we assess the complexity of Australia's economy, where Australia's revealed comparative advantages (RCAs) lie and our level of international engagement. We find that while Australia has a diversified domestic industrial base, this is not reflected in the complexity of Australia's exports, which are dominated by mineral resources. Indeed Australia has one of the lowest levels of export complexity among the Organisation for Economic Co-operation and Development (OECD) countries. Analysis of the relationship between innovation and export specialisation at the industry level across all sectors of the economy shows there is generally good alignment between innovation capabilities in a sector and that sector's international competitiveness. Finally, while Australia has been meeting the demand of some of the fast-growing economic sectors in the world, its position may be vulnerable in the long term. Australia has an exporting sector that is not diversified and may be vulnerable to external shocks.

3.1 Measures of international engagement

Table 3.1 shows select indicators of Australia's international engagement. The data show that, with the exception of raw commodity exports and net foreign direct investment inflows (which are being driven by investment in resources), Australia ranks relatively poorly with respect to indicators of international engagement against other OECD countries.

We're just a global company that happens to be based in Melbourne.

—Stuart Elliott, Planet Innovation

The DHL Global Connectedness Index[147] indicates that, with a score of 60, Australia has marginally improved its global engagement since 2005, but is behind the OECD average score of 64. A more considerable gap exists between Australia and the top five OECD countries (average score of 82). However, Australia ranks better in the McKinsey Global Institute's Connectedness Index (17th among 195 countries and 13th in the OECD). Australia's position is stronger in the pillars of the index that refer to people and finance, and relatively weak in trade, and data and communications.[148]

Three measures of international engagement on research and development (R&D) shown in Table 3.1 are the proportion of gross expenditure on R&D (GERD) financed from abroad, business expenditure on R&D (BERD) financed from abroad, and the R&D expenditure of foreign affiliates as a percentage of R&D expenditure of domestic enterprises. Australia's score in all three indicators has fallen significantly in past years. In the case of BERD financed from abroad, there was an increase of 0.3 percentage points in 2011 to 1.2% compared to 2010, an increase that was driven by an additional $44 million of BERD financed by overseas. However, Australia's ranking among OECD countries dropped to 27th in 2011 from 23rd in 2010.

Trade is one of the most powerful modes of international engagement, as it connects producers and users in global supply chains across borders. In 2013, trade (i.e. the sum of exports and imports of goods and services) was equivalent to 41% of Australia's gross domestic product (GDP) and, as Table 3.1 indicates, this proportion has not varied significantly since 1995. The number of goods-exporting Australian firms was an estimated 38,500 in 2012–13.[149]

Australia's trade as a percentage of GDP is significantly lower than the OECD average, with Australia ranking 25th in the OECD on this measure. Trade with Asia was about one-quarter of Australia's GDP, a figure that has remained constant in the five years before 2011.[150] Exports in raw commodities represented 9.6% of GDP, taking Australia's ranking on this indicator to 3rd among the OECD (Table 3.1).

Using the International Standard Industrial Classification,[151] the five largest export industries by average annual value (2008–12) were mining of metal ores (US$69.3 billion) and coal (US$42.7 billion), manufacture of basic metals (US$32.4 billion), petroleum and natural gas extraction (US$25.4 billion), and agriculture (US$19.2 billion). Travel[152] (US$26.5 billion;

147 Ghemawat P & Altman S A (2012) *DHL Global Connectedness Index 2012*, IESE Business School, Barcelona Spain.

148 McKinsey Global Institute (2014) *Global flows in a digital age* www.mckinsey.com/insights/mgi

149 ABS (2014) *Characteristics of Australian Exporters 2012–13*, cat. no. 5368.0.55.006; these data includes only goods exporters with an ABN; data on the number of exporters is not available for the service sector.

150 Australian Government (2012) *Australia in the Asian Century White Paper*, PM&C, Canberra

151 International Standard Industrial Classification of All Economic Activities, Rev.3, unstats.un.org/unsd/cr/registry/regcst.asp?Cl=2

152 The annual average for travel and transportation sectors is for 2007–11.

including higher education) and transportation (US$5.9 billion) are the only service industries in Australia's top ten (Tables 2.2 and 2.3). During 2008–12, Australian exports grew, on average, 9.2% per year.[153]

3.2 Has Australian industry been meeting global demand?

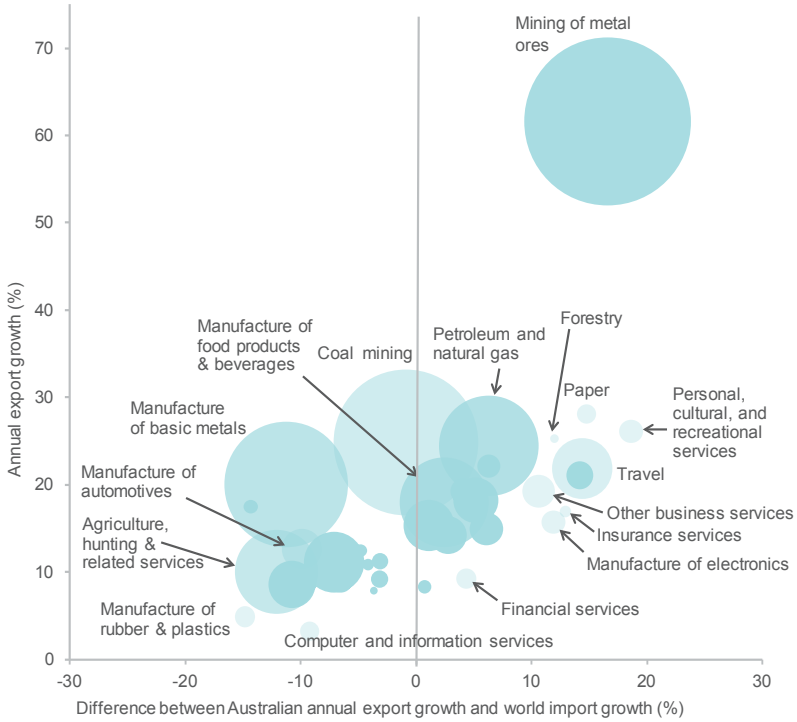
A proxy measure for gauging Australia's international competitiveness is to measure Australian export growth and see how it tracks against growth in world import demand. Faster export growth than world import growth in a particular sector indicates growing world market share, and may infer a competitive sector.

Figure 3.1 shows Australian export growth compared to world import demand growth by sector. Basic metals, automotive and agriculture are large sectors (in terms of exports) that have not kept pace with world demand. Mining, travel and other service sectors such as financial and insurance services have kept pace or outpaced world import growth, suggesting an improvement in competitiveness (Figure 3.1). Although metal ore and coal mining had the strongest export growth from 2008 to 2012, industries that are not among the top ten exporters achieved some of the highest growth rates—for example, personal, cultural and recreational services, and forestry and logging-related activities.[154]

153 For 2009–13, average export growth was just 3.9%, reflecting the absence of 2008 data, a year in which Australian exports grew by 32%.

154 United Nations COMTRADE data, comtrade.un.org.

Figure 3.1 Growth performance of Australian exports, by sector, 2008–12



Notes: Data are classified using ISIC (Rev 3). Size of the bubble indicates 2012 relative volume of exports.

Source: Melbourne Institute of Applied Economic & Social Research analysis commissioned by the Australian Government Department of Industry; and United Nations COMTRADE data, comtrade.un.org.

3.3 Where are Australia's comparative advantages?

An open, developed country like Australia should, in principle, specialise (and export) in a range of industries in which it is relatively more productive. For generally high-cost countries such as Australia, it is increasingly difficult to compete on input costs in many industries. Instead, value is increasingly associated with the uniqueness and quality of the goods and services offered to customers.

We use aggregated export data to look at broad trends for each sector of the economy. To understand Australia's competitiveness in individual industries, it is useful to analyse Australia's (RCA) based on exports from those industries (see Box 3.1).

Box 3.1 Revealed comparative advantage

Economists use the term comparative advantage when describing the choices a producer has to make. If a producer has a lower cost, or is better at producing a particular good or service relative to other possible goods or services,[155] this producer has a comparative advantage in that product or service. Differences in comparative advantages between producers create the basis for exchange through trade. At a global level, countries specialise and exchange goods and services through international trade.

$$\text{Revealed Comparative Advantage (Sector A)} = \frac{\left(\frac{\text{Australia's exports in Sector A}}{\text{Australia's total exports}}\right)}{\left(\frac{\text{World's exports in Sector A}}{\text{World' s total exports}}\right)}$$

Revealed comparative advantage (RCA)[156] is an index calculated using exports, providing a measure of relative specialisation of a country's export activities in an industry. The RCA is calculated as the proportion of a country's exports in that industry divided by the proportion of world exports in that industry:

If the RCA is greater than one, a comparative advantage is 'revealed.' If the RCA is less than one, the country has a comparative disadvantage in that industry. When RCAs increase or decrease, this can be because:

- of Australia's changing export composition
- Australia's share of total world exports for that sector are changing
- of change in the share of the world exports in that sector.

The RCA does not show the value added incorporated in exports, which has been a concern pointed out for the Organisation for Economic Co-operation and Development (see Chapter 4). However, comparisons between RCAs calculated on gross value of exports and value added associated to exports do not show significant differences for Australia's most important export sectors.[157]

The export data used to compute RCA can be of poor quality for several service sectors and may provide a distorted or incomplete picture of competitiveness in these sectors.

Tables 3.2 and 3.3 give trends in revealed comparative advantages and gross exports for Australia's industries. At the two-digit International Standard Industrial Classification (ISIC) level,[158] Australia shows revealed comparative advantages in ten identifiable sectors:

- agriculture hunting and related service activities
- fishing and aquaculture
- coal mining
- extraction of crude petroleum and natural gas
- mining of metal ores

155 Gans J et al. (2012) *Principles of economics*, 5th edition, Cengage Australia, Melbourne.

156 It is also called the Balassa Index after its inventor; see Balassa B (1965) Trade liberalisation and revealed comparative advantage, *The Manchester School* 33:99–123.

157 OECD-WTO (2013) TiVA (Trade in Value-Added) database, May 2013.

158 ISIC codes have many levels, or digits. The higher the level or digit, the more disaggregated is the industry.

- other mining and quarrying
- manufacturing of food products and beverages
- manufacturing of basic metals
- travel and personal, cultural and recreational services (reflecting both tourism and international education).

In many cases, an advantage at the broad (two-digit ISIC) industry level reflects a strong subsector (at the four-digit ISIC level), meaning that competitive advantage can often be in niche areas. For example, Australia has a revealed comparative advantage in the broad agriculture, hunting and related service activities (2.28 in 2008–12); however, closer analysis shows that Australia's comparative advantage is primarily in farming of cattle and sheep, with a secondary advantage in growing of cereals and other crops (see Figure A.12 in Appendix A). Mining and agglomeration of hard coal is the subsector behind high RCAs in the mining of coal and lignite sector (Figure A.13). Similarly, Australia's RCA in the manufacture of food products and beverages (1.33 overall in 2008–12) is dominated by the wine, meat processing and dairy industries.

Looking across all industries at the highest level of disaggregation, there are 19 industries where Australia shows a high RCA (Tables 3.2–3.4). Together, these 19 industry sectors accounted for 81% of our goods exports between 2008 and 2012, and 62% of our services exports between 2007 and 2011. All but one of the five highest RCA sectors are in mining, including uranium, iron and non-ferrous metal ores, in addition to hard coal. The only non-mining industry is farming of livestock and dairy farming. The remaining industries where Australia has a moderate comparative advantage are generally non-mining industries, including manufacture of basic precious and non-ferrous metals; production, processing and preserving of meat; manufacture of wines; growing of cereals and other crops; manufacture of dairy products; fishing; and manufacture of malt liquors and malt. More disaggregated data on service exports are unavailable; however, travel, and personal, cultural and recreational service advantages will most likely disaggregate to education and tourism-related services.

Many comparator countries, either in population or industrial structure, have a significantly higher number of specialised industries than Australia (Table 3.4). The RCA should not be considered in isolation from export volumes. For example, uranium ore mining has the highest RCA score of all Australian sectors (historical average of 52.0 in 1993–2009), but its total export volume is low (US$534 million in 2009).[159] Manufacturing of chemicals and chemical products, on the other hand, had a low RCA (historical average 0.39 in 1993–2009), but considerably higher export volumes ($5.8 billion in 2009 and US$8.1 billion in 2012). Figure 3.2 provides insights into the robustness and long-term competitiveness of Australian industries. The chart shows the growth trends of RCA and exports for all exporting industries at the most

159 Data for Australian exports of uranium ore mining after 2009 are not available in COMTRADE statistics.

disaggregated level available. Not surprisingly, there is a high correlation between the two growth measures.

The majority of Australia's industries are in the quadrant where export growth is increasing and competitiveness (i.e. RCA) is declining (Figure 3.2). Increasing world demand for Australia's exports can be a function of economic development, growing affluence and growing populations. Any of these trends around the world could be expected to increase demand, but it does not tell us who is capturing an increasing share of that growth. This is what changes in RCA values in Figure 3.2 show. In other words, Australian industries that have a positive change in RCA are more competitive, because they are displacing competitors and taking a higher share of the global export market.

Textiles manufacturing is an example of a sector that is in significant decline in Australia in terms of both international specialisation and export growth (Figure 3.2).

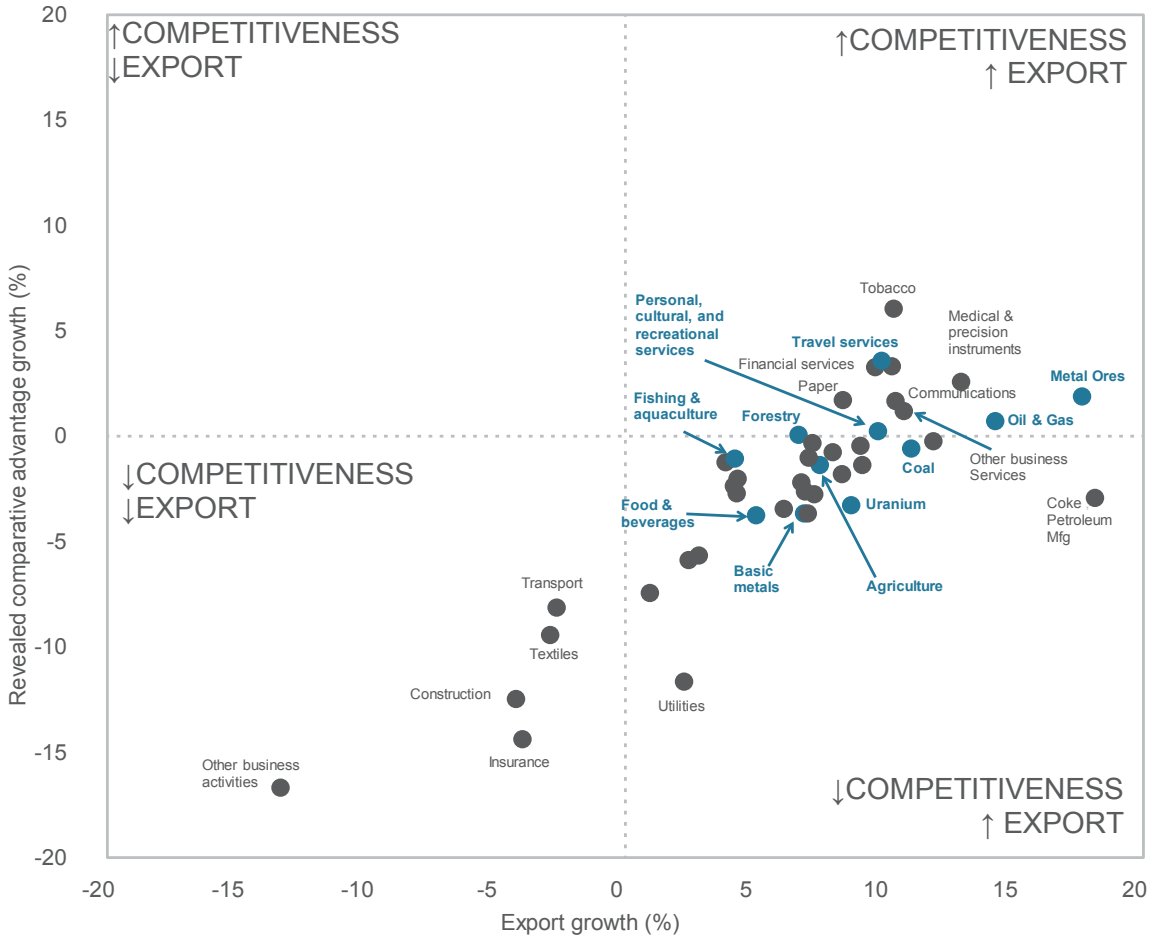
Australia's second highest revealed comparative advantage (RCA) is in mining of coal and agglomeration of hard coal. Australia's comparative advantage has decreased in recent years in this sector, whereas Australia's total export value has increased significantly (see position in the low-right quadrant of Figure 3.2). This may indicate that other competing countries are becoming more specialised in this sector and taking an increasing share of the global demand for coal. It is also likely that Australian growth in the production of this sector cannot keep pace with unprecedented global demand. Recent large mining investments may unlock this capacity constraint (see also Figure 3.1).

Australia's RCA in the manufacture of medical, precision and optical instruments, watches and clocks is 0.31 in 2012, but it has increased significantly from 1993 when it was 0.18 (note that the sector reached a maximum 0.56 in 2001). The overall increase in RCA since 1993 means that Australia has become more competitive in this sector, as it took an increasing share of the global export market in this sector (RCAs were 0.3 in 1993 and 0.5 in 2012). At the same time, Australia has increased its export value from a relatively low base of US$248 million in 1993 to US$2.9 billion in 2012. Increases in both RCA values and export value position the manufacture of medical, precision and optical instruments, watches and clocks sector in the top-right quadrant of Figure 3.2.

Australia is competing in the global stage … We've identified an industry that we have global recognition in, and we're plugging in our technology and capability to create global sports brands.

—Craig Hill, Australian Sports Technology Network

Figure 3.2 Industry growth in revealed comparative advantage and gross exports



Notes: Goods data use International Standard Industrial Classification of all economic activities at the two-digit level. Services data uses Extended Balance of Payments Services classification at the three-digit level. Compound annual growth rates cover 1993 to 2012 for goods sectors and 2006 to 2011 for services sectors. Sectors with high revealed comparative advantages in 2008–12 are highlighted in blue.

Sources: UN Comtrade Database (comtrade.un.org/); for Australia's export in 2009–11: ABS, International trade in services by country, by state and by detailed services category, calendar year, cat. no. 5368055004; and World Bank DataBank (databank.worldbank.org) for Australian exchange rates.

Australia is a fantastic test bed for innovation. We've closed the loop on the whole innovation ecosystem—we've got the key players at the table … Once the SMEs have tested their product here there's no reason we can't take their products straight into North America or to Europe.

—Craig Hill, Australian Sports Technology Network

Box 3.2 Where are our future growth prospects?

Two recent reports by Deloitte-Access Economics[160] and McKinsey Australia[161] have attempted to analyse which sectors in Australia have future growth potential that will ensure our future prosperity. Both reports emphasised a sense of urgency required to generate the next wave of wealth creation beyond the current mining boom. Each analysis used a different method.

Both reports emphasise a global mindset that needs to be adopted by all sectors of the economy, including previously domestic ones, to reorient our economy to major global trends such as climate change, the digital economy, demographic shifts and the competitive industry policies being introduced by other nations. Businesses need to dramatically increase their competitiveness through innovation (particularly business model innovation), and governments need to complement these investments by continuing to build innovation and skills infrastructure.

According to the Deloitte report, Australia needs new growth drivers (i.e. sectors that are expected to grow significantly faster than the global gross domestic product of 3.4%). They identified mining as the current wave, with gas, tourism, agribusiness, health, international education and wealth management collectively matching the wealth creation of mining today. Beside growth prospects, Deloitte also emphasised other comparative advantages that are hard for other nations to match. These include:

- world-class resources in land, minerals and energy
- proximity to the world's fastest-growing markets in Asia
- use of English, the world's business language
- a temperate climate
- well-understood tax and regulatory regimes.

The Deloitte report also underscores benefits of lower currency rates for Australia. It expects the Australian dollar to settle at US$0.80 in the longer term, which will be good news for sectors such as manufacturing, farming, tourism and international education.

160 Deloitte (2014) *Positioning for prosperity? Catching the next wave*, Building the lucky country #3, Deloitte Touche Tohmatsu.

161 Lydon J, et al. (2014) *Compete to prosper: improving Australia's global competitiveness*, McKinsey Australia.

Comparison of sectoral growth opportunities

	Deloitte-Access Economics	Business Council of Australia—McKinsey
Leading sectors	Gas, tourism, agribusiness, health, international education, wealth management. niches performers in residential care, finance, next-generation nuclear, next-generation solar, medical research, community care, preventative health care, digital health care delivery, reskilling an ageing workforce, retirement leisure, ocean resources, private schooling, clean coal, disaster management, gas transport, parcel delivery, food processing	Mining, agriculture, tourism, education & niche performers at a subsector level, such as medical device manufacturing
Sectors with potential	Water and waste services, retail and wholesale, other education and training, public administration, transport and logistics, business and property services, telecommunications, oil, banking, mining, construction	Food manufacturing, niches in advanced manufacturing, elements of global supply chains like design and engineering services
Transitional/ enabling/ domestic core	ICT, manufacturing & media	Most of manufacturing, finance, utilities, construction, professional services, logistics, real estate services, communications, retail and wholesale trade, domestic services and public services

The McKinsey report, funded by the Business Council of Australia, stresses the need for Australia to be competitive, particularly in traded sectors. It argues that, to succeed, Australia must be broadly competitive with peer nations, and 'world beating' in a few and very specific areas. The report breaks the economy into five categories:

- advantaged performers (mining, agriculture, education and tourism)
- latent potentials (food manufacturing, pockets of advanced manufacturing and selected niches in global supply chains)
- transitionals (most of manufacturing)
- enabling industries (finance, utilities, construction, professional services, logistics, real estate services)
- domestic core (communications, retail and wholesale trade, domestic services and public services).

The report argues that it is the advantaged performers and the latent potentials where Australia tends to have the right combination of skills and endowments to win globally.

As noted in Box 3.2, Australia's close proximity to Asia gives us a competitive advantage.

Box 3.3 Feature: the Asian challenge for Australian agriculture—turning reputation into dollars

By Vera Lipton, Christine McDaniel and Benjamin Mitra-Kahn, IP Australia[162]



Asian economies are growing—fast. As part of this growth, demand for food and agricultural products has increased rapidly, and there is general agreement that Australia has the potential to take advantage of this growing demand. To some extent we already have, with food exports to Asia doubling from $9 billion in 2003 to $18 billion in 2012.

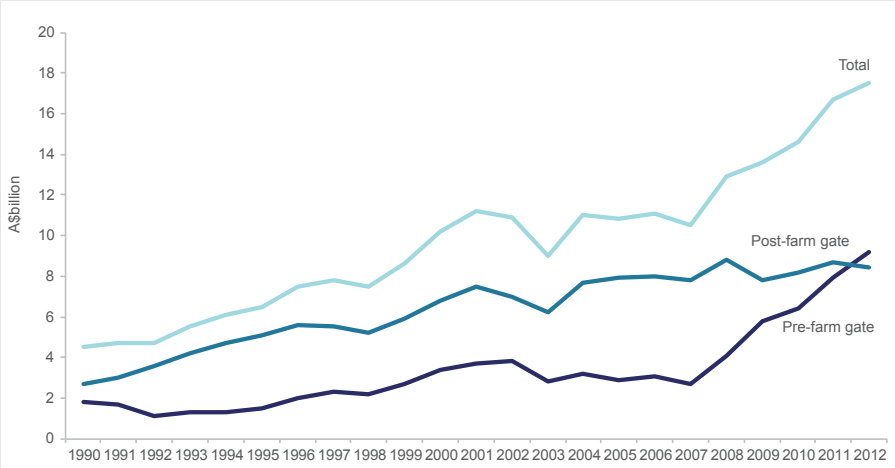
The question is how Australian exporters can further capitalise on its strengths in agriculture in the Asian market. This means identifying Australia's innovative strengths in the sector and comparing them against potential areas of growth in the region.

From pre-farm gate to top-shelf produce

Pre-farm gate goods have been the main driver of export growth to Asia in the past decade and are likely to continue as an important income source (Figure 3.3). These goods tend to be in areas that are highly commoditised, such as grain or livestock, with little room for brand differentiation.

162 Vera Lipton, Senior Analyst, IP Australia; Christine McDaniel, former Deputy Chief Economist, IP Australia; Benjamin Mitra-Kahn, Chief Economist, IP Australia. The views presented here are those of the authors and do not necessarily represent the views of IP Australia or the Australian Government.

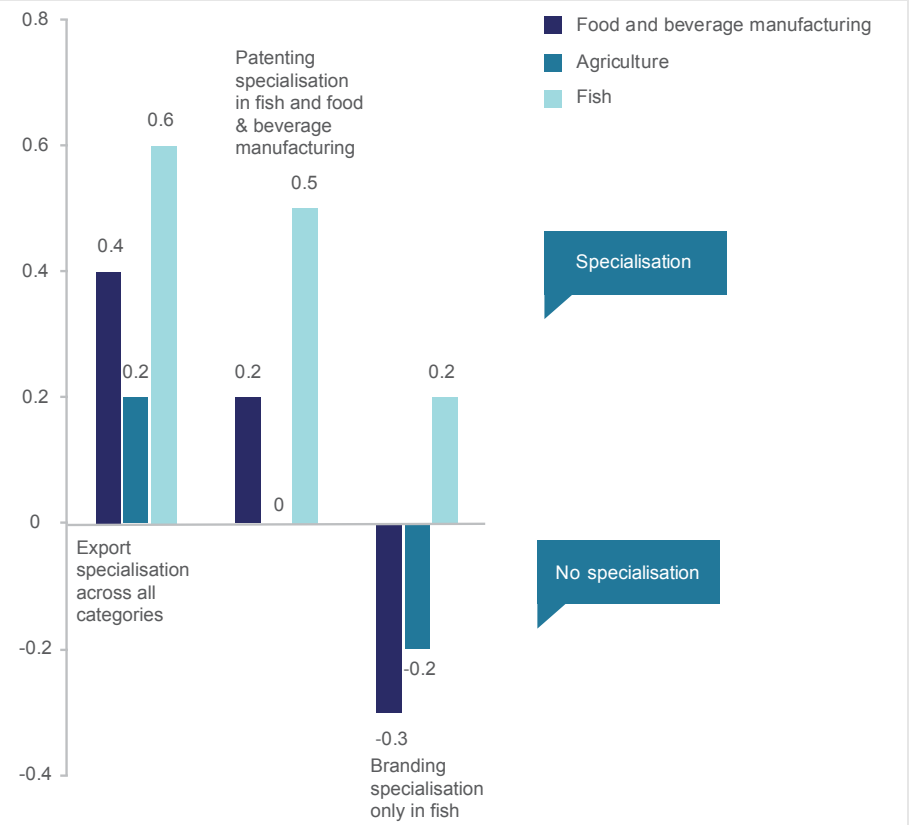
Figure 3.3 **Australia agricultural exports to Asia**: pre-farm gate has driven export growth



Note: Asia includes central, southern and east Asia (i.e. north-east Asia and South-East Asia).

Source: Composition of Trade Database, Australian Government of Department of Foreign Affairs. Trademark data reflect Australia's lack of brand differentiation in the sector. Australia does not exhibit a branding specialisation in agriculture and hunting, or food and beverage manufacturing (Figure 3.4). At the same time, Australia specialises in patenting and exporting of food and beverages, as discussed below.

Figure 3.4 Export, patenting and branding specialisations in key Australian agricultural goods



Note: The figure depicts revealed comparative advantage indexes calculated for export, patenting and branding. A number greater than zero indicates specialisation. For example, '0.2' in patenting for food and beverage manufacturing indicates that Australia's share of food patents is greater than the global share of food patents.

Source: IP Australia calculations.

Another way in which Australians harness the value of agricultural innovations is with plant breeder's rights, protecting new crop varieties. Commodities such as wheat, barley and sugar—all top Australian agriculture exports—are all protected. Industry data indicate that 229 protected wheat varieties are associated with some 85% of Australia's wheat exports (a total of $5.5 billion in 2011). Australia's protected wheat varieties include those that are drought tolerant, such as 'Drysdale' and 'Rees4', both of which are the result of CSIRO research and collaboration with industry.

A changing Asia with changing opportunities

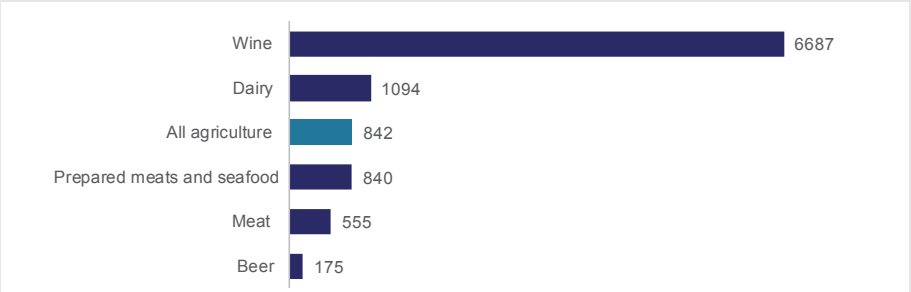
Pre-farm gate goods are likely to remain a large share of Australia's agricultural exports. In parallel, a sustained increase in consumer income across Asia is shifting focus towards processed foods, also known as post-farm gate products.

The Chinese diet is a case in point. In the past few decades, consumption of food grains per person has declined by almost 40%. Meanwhile, demand for wine, dairy, meat and seafood has grown, and dairy consumption per person quadrupled

since 1990.[163] If we consider the sheer scale of demand, the market opportunities become clear (Figure 3.5).

Figure 3.5 Chinese growth in selected food and beverage imports (%), 2002–12

Source: UN Comtrade and IP Australia calculations.



Importantly, Australian strengths in food innovation match the areas of growth in Asia. These strengths are in beverages and dairy products (Figure 3.6). Australian inventors file more patents relating to beverage and dairy than the world average. Regional patenting specialisations include South Australia's wine and beer brewing, Queensland's meat slaughtering, and Victoria's beverages.

Figure 3.6 Technological specialisations in beverages and dairy across Australia

Source: Department of Industry (2014) The Australian food industry: a patent report.

In addition to its strengths in agrifood innovation, Australia has developed a world-class reputation as a food and wine tourist destination.[164] Australia is therefore well positioned to convert its reputation into higher returns. Intellectual property already plays an important role in this process and will continue to do so into the future.

Value creation by internationally competitive sectors is distributed across the economy indirectly through domestic supply chains. We investigate value-added trade data and show that Australia has hidden sectors of international

163 See Zhou Z et al. (2012) *Food consumption trends in China*, report submitted to the Australian Government Department of Agriculture, Fisheries and Forestry, Canberra.

164 In 2012, Australia ranked as the 2nd favourite destination among food and wine tourists; see Food and Wine Tourism Survey, BDA Marketing for Tourism Australia.

competitiveness. Australia shows some strength in business services, transport and telecommunication, and close to zero gross trade surpluses in construction, utilities and financial intermediation. The international competiveness of a sector should not be viewed in isolation from its suppliers. Using value-add methods, we find that largely domestic services are important for the international competitiveness of other industries, particularly manufacturing.

The literature shows that innovation, particularly world-first innovation or collaborative innovation, is fundamental to participation in global value chains. Australia's poor performance in both these activities may explain our below OECD average participation in global value chains.

3.4 Alignment between innovation capabilities and revealed comparative advantage

Chapter 2 demonstrated a strong association between innovation and exporting activity at the firm and sectoral level. It also showed the growing importance of investments in intangible, knowledge-based capital such as research and development (R&D) and intellectual property to innovation-driven firms' competitiveness. This section applies the revealed advantage method to intermediate outputs of innovation such as patents and trademarks. Revealed technological advantage (RTA) and revealed brand advantage (RBA) use patent applications and trademark data, respectively. Our intention is to demonstrate the degree of alignment between international competitiveness and strengths in innovation capabilities in each sector of the economy.

Trademarks *are the outcome of establishing recognisable designations and symbols for goods and services, as well as firms' identities. They play a crucial role in the process of marketing innovations, being instrumental in differentiating the attributes of goods and services in the marketplace. The use of trademark data to produce what we have called Revealed Brand Advantage (RBA) has never been done before according to our knowledge. Trademark data are considered a useful complementary measure of innovation activity in business compared with patents, because of its broader applicability to service industries.*[165]

Figure 3.7 shows the alignment between Australia's innovation capabilities (using R&D, patents and trademark data) and its revealed comparative advantages (RCAs) for sectors with high RCA (i.e. more than one). Figures A.14 to A.17 provide more detail on sectors with low RCAs. Many of the primary industries where we have high comparative advantage also coincide

165 For a more detailed review, see Mendonça S et al. (2004) Trademarks as an indicator of innovation and industrial change, *Research Policy* 33:1385–1404.

with research, technical and brand strengths in the same industry (Figure 3.7).

Agriculture has a high RCA, which has declined marginally since the early 1990s (Figure 3.2, Table 3.2). Survey data show that agriculture has a below-average proportion of innovators in the sector compared with other sectors of the Australian economy (Table 2.2). This is likely due to the very high proportion of small farming businesses that dilute the large investments in R&D made by a few very large companies in the sector. However, the sector's export and technological advantages are still relatively high (Figure 3.7) and multifactor productivity has been growing, suggesting the sector still has an internationally competitive position underpinned by strong innovation capabilities.

The high R&D intensity for aquaculture may be responsible for the relatively high R&D intensity for the broader agriculture, forestry and fishing sector shown in Figure A.18. Aquaculture is a stand out performer, with a high R&D intensity at 2.75%, and strong international technological and brand advantages (Figure A.14, Table 2.2). Exports in fishing and aquaculture have grown in recent years despite a decline in RCA (Table 3.2).

The mining sector remains Australia's area of greatest international competitiveness, both in terms of comparative advantage and export value to Australia (Table 3.2). This sector is supported by outstanding innovation capabilities in many areas—mining and agglomeration coal, oil and gas, and iron ore have very high technological advantages and high R&D intensities. The labour productivity of the sector is very high because it is highly capital intensive (Figure 3.7). Mining services (captured in 'other mining and quarrying'), although not driving exports themselves, contribute heavily to the technological and scientific capabilities that the rest of the mining sector enjoys (Figure A.14, Table 2.2). The R&D intensity of exploration and other mining support services is 21% (Table 2.2).

By contrast with many of Australia's primary industries, manufacturing appears weaker in terms of international competitiveness (Figures A.15 and A.16). Labour productivity of this sector is relatively low by OECD standards, and its multifactor productivity has been relatively flat in the past 20 years. Only in food product manufacturing and basic metal manufacturing do we have high RCAs (Figure 3.7) and both these sectors have trended down despite exhibiting high growth in gross exports (Table 3.2). Both these sectors have levels of innovation and high R&D intensities above the Australian and Organisation for Economic Co-operation and Development (OECD) median (Table 2.2, and Figures A.15, A.17 and A.18). Both sectors also have technological advantages that are around world average.

The rest of the manufacturing sector has low RCA scores that have declined in recent years, even though export demand is growing for many of these sectors (Table 3.2). Manufacturing is generally characterised by low rates of exporting and very high import competition in the domestic market (Table 3.2; also see Appendix B). Strong domestic innovation capabilities exist in

these sectors that may provide the platform for establishing themselves in international markets or global supply chains in the future.

Many case studies in this report and others[166] show successful Australian manufacturers, particularly advanced manufacturers; occupying unique niches in international markets (see Box 2.1 for an example). Many of these sectors have moderate to high technological and brand advantages, mixed with very high R&D intensities and high rates of innovation (Table 2.2, and Figures A.15 and A.16).

However import competition is very high in advanced manufacturing sectors and OECD competitors have significantly higher R&D intensity (Figure A2.7). The Australian Workforce and Productivity Agency[167] argued that, apart from aerospace, and medical technology and products, many Australian manufacturing innovations remain locked in public research organisations. The broader manufacturing sector could leverage greater competitiveness from higher collaboration with the research sector. These opportunities are discussed in more detail in Chapters 5 and 8.

Unfortunately, service sector information both internationally and domestically is poor and/or highly aggregated for almost every type of indicator. From the limited quantitative service sector information, we can obtain it is clear that education-related travel and tourism are highly specialised, competitive industries in Australia (Figure 3.7; Table 3.3). Considering its size, Australia maintains a relatively high market share (6%) of international students, ranking us 5th in the world.[168]

The tourism sector has a strong brand advantage. In fact, many service sectors have above-average brand advantages. Business services—such as telecommunication, and computer and information services sectors—have high innovation percentages and above OECD median R&D intensities, although they have below OECD median labour productivity (Figure A.18, Table 2.2). RCA scores for these two sectors are not more than one, but are either close to one (computer & information services) or growing (telecommunications). Both exhibit growth in gross exports (Figure 3.1, Table 3.5).

Services contribution to trade is underestimated using gross exports alone because of their contribution to the exports of other sectors of the economy, such as mining and manufacturing.[169] Business services sectors have slight gross trade surpluses in value-added terms for this reason. For further discussion of value-added trade and domestic trade flows between sectors see Chapter 4.

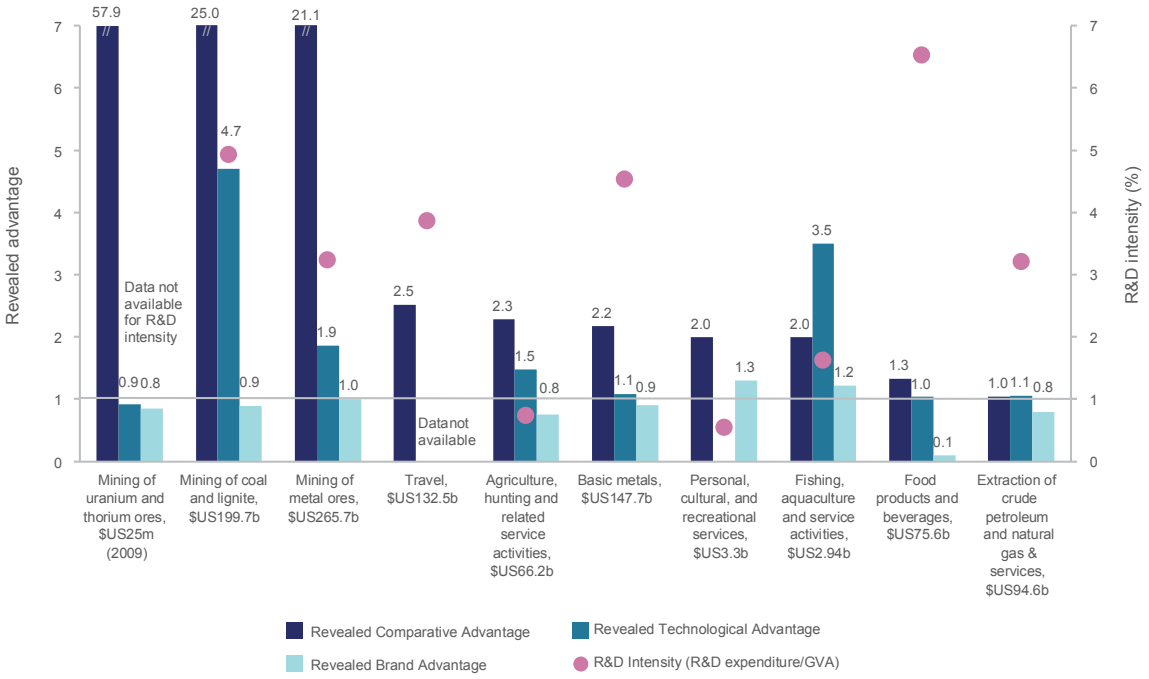
166 ACOLA (2014) *The role of science, research and technology in lifting Australian productivity*, Securing Australia's future Project 4 final report, www.acola.org.au.

167 AWPA (2014) *Manufacturing workforce study*, pp. 58-9, www.awpa.gov.au/our-work/sector-specific-skill-needs/Manufacturing_workforce_study/Pages/default.aspx.

168 See Chapter 7 of this report, and the *Australian Innovation System Report 2013*, pp. 89–92, www.industry.gov.au/aisreport.

169 Kelly G & La Cava G (2014) International trade costs, global supply chains and value-added trade in Australia, Reserve Bank of Australia, RDP 2014-07, Canberra.

Figure 3.7 Australia's revealed advantage, for exports (RCA), patents (RTA), trademarks (RBA) and R&D intensity, high RCA sectors, 2008–12



Source: UNCTAD COMTRADE database; IP Australia customised data request.

Box 3.4 Case study: innovation in the construction sector

Construction is a large industry, with around 10% of Australia's employment and industry value added in 2012–13.[170] Construction services accounted for 56% of construction industry value add and 67% of its employment in 2012–13. Construction is a predominantly domestic industry, with historically very low import competition (see Table 2.2). Building construction and construction services have a below-average proportion of innovation-active businesses, and heavy and civil engineering construction have above-average innovation (Table 2.2). Heavy and civil engineering construction, and building construction have above-average research and development (R&D) intensities at 3.34% and 2.46%, respectively. Both these are considerably higher than the median R&D intensity for the OECD (0.19%). Between 1993 and 2012, construction shrank in both gross exports as well as global export market share (Figure 2.2).

Like many domestic industries, construction is a diverse industry with many individual firms that are highly innovative and globally competitive. This is particularly apparent in a number of construction and construction-enabling services, such as finance, engineering, project management, architecture, design, infrastructure delivery and maintenance. Three construction businesses, Hickory Group (5th), Laing O'Rourke Australia (8th) and Aconex (43rd) were listed in Business Review Weekly's top 50 innovators in Australia for 2014.[171] Companies

170 ABS (2014) *Australian Industry*, 2013–14, cat. no. 8155.0, ABS, Canberra.

171 BRW (2014) 50 most innovative companies 2014, www.brw.com.au/lists/50-most-innovative-companies/2014.

like Urban Circus,[172] Ecospecifier,[173] the Green Building Council of Australia[174] and the Sustainable Built Environment National Research Centre[175] demonstrate innovation leadership for Australia. Australia and New Zealand is a leading region according to the Global Real Estate Sustainability Benchmark.[176]

According to Paul Hodgson, General Manager of Strategy at Construction Skills Queensland, 'many construction companies, particularly residential, haven't yet felt the full effects of global competition due to the "on-site" nature of the work creating a "local" advantage. However, the recent entry of global firms such as Sekisui House into the domestic market, signals increasing globalisation. As pressure for innovation undoubtedly increases, related sectors such as manufacturing, agriculture and resources have technologies and methodologies that could be deployed relatively quickly in general and civil construction'.

Many of the Construction 2020 visions[177] produced in 2006 by the CRC for Construction Innovation, are coming to pass. Technologies such as 3D printing/robotics, building information modelling[178] and modular/prefabrication/off-site construction may bring significant global, competitive pressures, particularly to the traditional on-site construction sector.[179] Australia has a number of global players operating in Australia such as Macquarie Group, AECOM and Leightons that can quickly bring these new disruptive innovations into Australia.

Paul explains, 'If a building can be designed on a computer, built off-site anywhere in the world and put together on-site by robots, then construction potentially becomes disrupted by global factors and players as much as the manufacturing sector. This will likely boost innovation as a necessity but, as mentioned, we could deploy this from related sectors quickly'.

3.5 Economic complexity as a measure of competitiveness

As globalisation fragments production across borders, the nature of production and national competitiveness is becoming more complex. Traditionally, it has been thought that the most prosperous of nations have specialised, to a high degree, in the production of only a few products.

This Ricardian view has been challenged recently by practitioners of a new field of research called 'complexity economics'.[180] Harvard University and Massachusetts Institute of Technology academics Hidalgo and Hausmann[181] proposed a complexity approach to measuring the intangible elements that drive the competitiveness of countries using international trade data. They

172 www.urbancircus.com.au
173 www.ecospecifier.com.au
174 www.gbca.org.au
175 www.sbenrc.com.au
176 GRESB (2014) 2014 *GRESB report*, www.gresb.com
177 www.construction-innovation.info/images/pdfs/2006_update_-_final_version.pdf
178 www.bimmepaus.com.au/about-us.html; buildingsmart.org.au/about-us
179 www.prefabaus.org.au
180 www.prefabaus.org.au
181 Hidalgo CA & Hausmann R (2009) The building blocks of complexity, *PNAS* 106(26):10 570–75

and others[182] find that wealthy, competitive countries are characterised by a high degree of diversification of exports, where countries produce all the possible products they can limited only by their level of innovation, development and natural resources.

Although firms and industries specialise to a high degree in particular products, more diversified countries (with more specialised sectors) tend to have higher economic growth at a macroeconomic level.[183] This complexity approach to exports reveals that product complexity is an indication of the capabilities that each country possesses. Product complexity is also predictive of future growth and of the complexity of future exports.[184]

An economy that makes and exports a large variety of unique products is in a strong competitive position. Innovation is the key driver of market diversification as shown through its influence on the range of goods and services offered by businesses (Figure 3.8) The variety of products provides economic resilience and their uniqueness not only incorporates more value add, but also potentially makes it more difficult to imitate. See the case study in Box 3.5 for an example of an Australian company thriving in innovation and exports.

The diversity of exports of a country can be seen as an indirect measure of the knowledge, skills, technologies, resources, framework conditions and other capabilities of that country at any point in time. These capabilities are often intangible and not easily traded. In other words, the higher the diversity of exports of a country, the larger is the range of capabilities available in that country. As Hausmann and colleagues point out 'what countries make reveals what they know'.[185]

The set of capabilities used by a nation to produce certain goods and services is conceptually linked to the definition of a national innovation system.

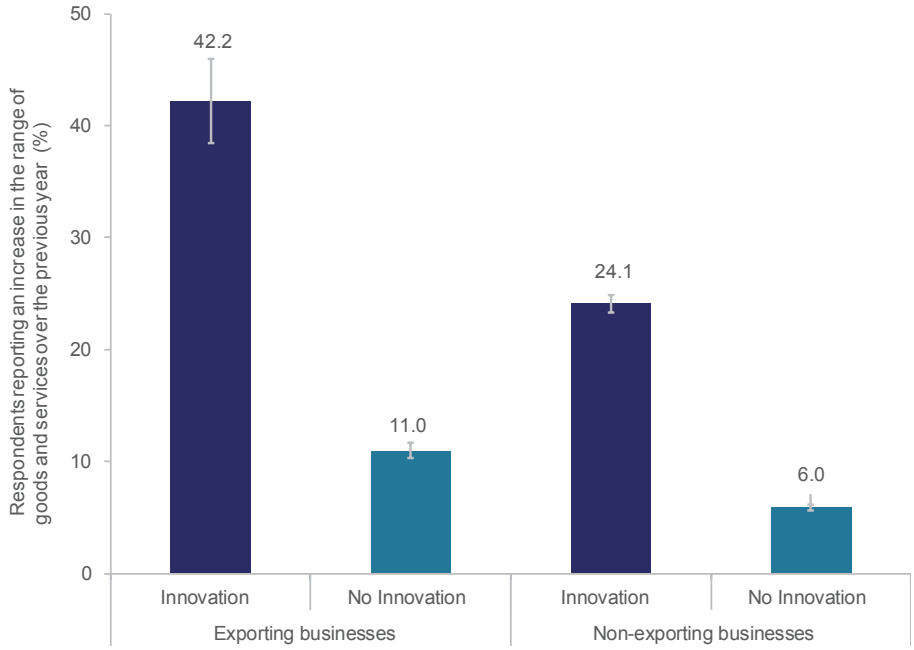
182 Cristelli M et al. (2013) Measuring the intangibles: a metrics for the economic complexity of countries and products, *PLOS* One 8(8):1–20.

183 Shaw J (2010) Complexity and the wealth of nations, *Harvard Magazine*, March–April. harvardmagazine.com/2010/03/complexity-and-wealth-of-nations

184 Hidalgo C A & Hausmann R (2009) *The building blocks of complexity*, PNAS 106 (26):10 570–75.

185 Hausmann R et al. (2013) *Atlas of economic complexity: mapping paths to prosperity*, Center for International Development, Harvard University, p. 21.

Figure 3.8 Growth in the range of goods and services produced, by innovation and export status, 2012–13



Source: ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

Box 3.5 Case study: Lumen[186]

Although the announcement of planned exits of the major automotive assemblers from Australia in coming years has drawn much media attention, innovative Australian companies continue to defy the gloomy commentary.

Lumen iPads

Lumen specialise in the design and manufacture of automotive products that improve driving safety and comfort. They work closely with their customers to meet the expectations of today's motorist, while seamlessly integrating ideas and technology so new and exciting concepts become a reality.

Lumen has gained a competitive edge by connecting local knowledge to global capabilities. Their head office is in Melbourne, and sales, manufacturing and distribution centres are located in New Zealand, Poland, Germany, Taiwan, China, South Africa, Thailand and North America.

With 30 years' experience in the industry, they have forged strong working partnerships with many of the world's leading automotive companies through a commitment to deliver flexible, reliable and advanced customised solutions.

186 Based on an interview conducted on 12 June 2014.

Expert teams operating from a dedicated design centre in Melbourne deliver diverse product development capabilities, including 3D CAD, industrial design, graphical illustration, electronic and mechanical engineering.

Exploded car

Around 135 of Lumen's approximately 350 staff worldwide are employed at the company's design centre in Melbourne. Of those, about 40 work full-time on design and engineering. Lumen originally started out developing trailer sockets in the 1980s. But it was able to successfully expand into parking sensors, rear-view cameras and blind-spot detection systems. Building on these core competencies in vehicle electronics, the company grew with the industry into developing infotainment and safety systems.

So how does Lumen innovate? For Lumen, it means staying on top of the next big thing by attending trade fairs and networking events. According to Lumen R&D Product Design Engineer Ben Bartlett, 'we rely heavily on what's already in the market … We look at what the top-end manufacturers are doing and we see if we can deliver a similar product that is more cost effective'. This often means adapting the latest technology found in high-end European cars and bringing it to the mainstream. Crucially, it also often means looking at new technology, such as in information technology, that would not otherwise be used in vehicles and then adapting it. Lumen would not exist without this kind of lateral thinking about product development. Or as Ben puts it: 'We wouldn't exist without innovation'.

For instance, a major project like the blind-spot detection system (now being purchased by Toyota and Mazda) involved adapting radar technology in a practical, cost-effective way. It took around two years of research and development before it could be taken to engineering. Ideally, however, the faster a product can be delivered to the market, the better. Ideally, this would be 12 months or less.

Over the years, Lumen has developed good relationships with many of the major mid-range car manufacturers like Toyota, Mazda, Kia and Hyundai, who now approach them with requests and suggestions. According to Ben, 'the company started off as a small niche market player, but that niche is getting more and more volume behind it'.

Despite expansion around the world, including some design in Poland, and manufacturing in Taiwan and Thailand, Australia remains the central hub for product development.

Lumen is a prime example of the fact that Australia can continue to compete globally in niche manufacturing. In Lumen's case, it means innovating through market segmentation and cost-effective products in the highly competitive automotive accessories market.

3.5.1 Australia's level of economic complexity

Hausmann and colleagues developed their economic complexity index (ECI) using export data.[187] The economic complexity index incorporates two key concepts: diversity and ubiquity of exports. Diversity is related to the number of products that a country exports, whereas ubiquity tells us how unique the products that a country exports are.

The ECI is the resulting quantitative measure of national competitiveness. Figure 3.9 follows an exponential trend and shows that, generally—although not always—the richest countries are those with the most complex economies. Similar to other resource-rich countries such as Canada, Norway and Kuwait, Australia has a considerably lower ECI score than most advanced economies.

According to the ECI, Australia has the sixth highest income with a low (negative) index of economic complexity.[188] In addition, the Australian economy has become less complex in the past ten years. This means that Australia's capacity to be internationally competitive in a range of diverse and complex products has declined, and we rank as one of the countries with the least diverse exports within the OECD.[189] This poses a risk for Australia, as we may not have sufficient prospects for enduring growth as global demands change.

Although Australia has a diversified domestic industrial base, this is not reflected in the complexity of its exports, which are dominated by mineral resources. Australia had the lowest ECI among the OECD countries in 2010 (Figure A.17). These data are consistent with earlier findings (Table 3.4).

The data from the Atlas of Economic Complexity indicates a sharp decrease in this index since its highs in 2000 for Australia.[190] The head of the Australian Industry Group suggests that the drop in complexity is associated with the decline in the range of manufactured goods produced in a country.[191] Many other OECD countries have also seen their ECI decrease, yet the United States (US) and Australia are the most dramatic

187 See Cristelli M *et al* (2013) Measuring the intangibles: A metrics for the economic complexity of countries and products, *PLOS One* 8(8):1–20. Although Cristelli et al. have similar findings for Australia, they have the following criticisms of the ECI method: it only includes data on exports, not production. However, the fact that a country produces goods that cannot be exported may be indicative of low productivity or quality. Also, services are not included in the ECI dataset, which is problematic, as services are a large part of advanced economies and important for trade.

188 This is evidenced by the fact that 69% of Australian Stock Exchange (ASX) market capitalisation is held by two industries (mining and finance); and four banks and two companies account for approximately half of the market capitalisation of the ASX.

189 The data from the *Atlas of economic complexity* suggest that Australia, compared to other advanced economies, has had a less-diverse export sector historically, which implies the non-resources sectors (mainly manufacturing sector) were not competitive in export markets.

190 Hidalgo CA & Hausmann R (2009) *The building blocks of complexity*, PNAS 106(26):10 570–75.

191 Willox I (2014) Chapter 3, Advanced manufacturing beyond the production line, in: *Advanced manufacturing: a smart approach for Australia*, Committee for Economic Development in Australia.

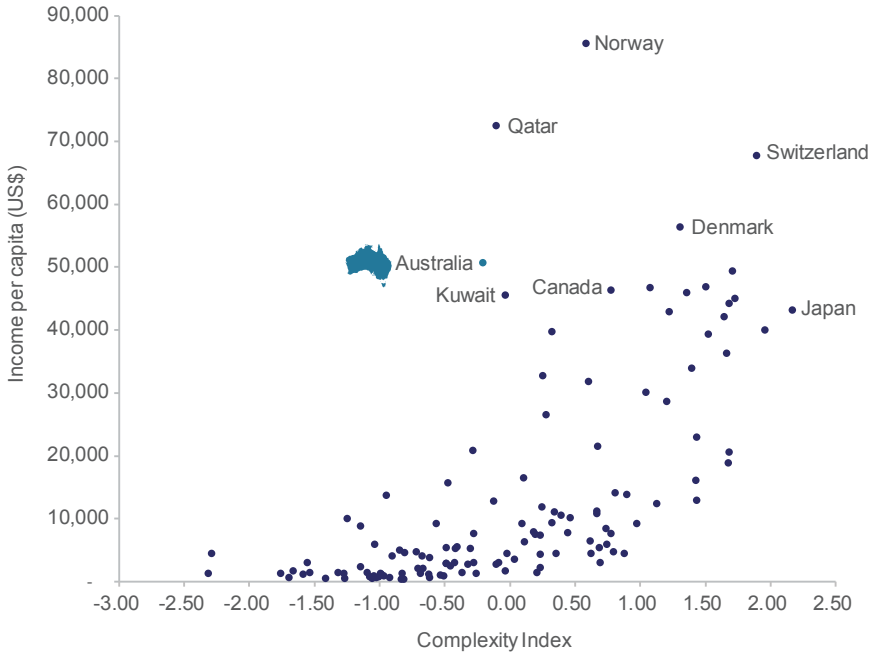
With any product, and particularly with a product like coffee, a core part of being successful is being able to make that connection with your audience or your consumer, and maintaining that connection. There's got to be a personal and emotional connection. The best way to do that is through the brand.

—Michael Drummond, Di Bella Coffee

cases. This is partially due to the shifting of manufacturing from the OECD economies to the new industrialised countries in Asia. South Korea ranked fifth in the OECD in terms of the complexity of its economy, and has the biggest ECI increase among the OECD countries between 2000 and 2010. Austria, the United Kingdom and Switzerland have also increased their ECI in the same decade. Switzerland, in particular, has been able to maintain the manufacturing value added as proportion of its GDP at a constant 19% throughout the decade,[192] and ranks 3rd in terms of economic complexity.

Pisano and Shih argue that increasing de-industrialisation of the US is fostering the disappearance of capabilities that are essential for its innovative and competitive capacity in the future.[193] This may also apply to Australia where the loss of complexity (hence skills and advanced capabilities) may represent an obstacle for developing future areas of technology and manufacturing specialisation that depend heavily on innovation.

Figure 3.9 Income per capita vs economic complexity index, 2010



Note: An exponential curve fits the data with an R-squared of 0.56.

Source: Hausmann R et al. (2013) The atlas of economics complexity: mapping paths to prosperity, Center for International Development, Harvard University.

192 data.worldbank.org

193 Pisano G and Shih W (2012) *Producing prosperity: why America needs a manufacturing renaissance*, Harvard Business Press Books, Boston.

Table 3.1 Main indicators of Australia's international engagement

Australian Trend Data (i)												OECD Comparisons				
Indicators	1995	2000	2005	2007	2008	2009	2010	2011	2012	2013	2014	Australia's score (ii)	OECD average (iii)	OECD top 5 average (iv)	Gap from the top 5 OECD performers (%) (v)	Ranking against OECD countries (vi)
DHL Global Connectedness Index, score[1] [(a)]	–	–	57	59	60	61	60	60	–	–	–	60	64	82	26	21
Trade, % of GDP [2] [(a)]	38	41	39	41	42	45	40	41	43	41	–	41	100	196	79	25
Exports in goods, % of GDP [3] [(b)]	13.6	15.6	15.3	14.5	17.7	15.3	16.5	17.8	20.0	–	–	16.2	37.7	75.5	79	31
Exports in services, % of GDP [3] [(b)]	4.6	4.7	4.0	4.1	4.5	4.1	4.0	4.0	4.1	–	–	4.1	12.0	36.5	89	3
Exports in raw commodities, % of GDP [3] [(c)]	–	–	–	5.9	9.6	8.1	9.7	10.0	9.6	–	–	9.6	3.8	10.1	5	3
Net Foreign Direct Investment inflows, % of GDP [3]	3.3	3.3	–3.5	5.3	4.3	3.0	3.0	4.9	–	–	–	4.9	3.9	14.5	66	8
FDI and technology transfer, 1–7 (best), score [4] [(d)] [(g)]	–	–	5.2	5.4	5.5	5.4	5.2	5.1	5.0	5.2	–	5.2	4.9	5.5	5	6
Business impact of rules on FDI, 1–7 (best), score [4] [(e)] [(g)]	–	–	5.4	5.3	5.3	5.1	4.9	4.9	5.0	4.9	–	4.9	4.7	5.7	14	13
Technology balance of payments (receipts minus payments as a % of GDP), % [5] [(h)]	–0.048	–0.167	–0.096	–0.136	–0.199	–0.187	–0.215	–0.23	–0.214	–	–	–0.214	0.321	1.796	112	21
Intellectual property balance of payments, million A$ [6]	–	–1319	–1832	–2492	–2656	–2588	–2659	–3065	–3214	–3166	–	–	–	–	–	–
Percentage of Gross Expenditure on R&D (GERD) financed by abroad, % [5] [(h)]	1.9	3.5	2.9	–	1.6	–	–	–	–	–	–	1.6	8.1	18.6	91	23
Percentage of Business Expenditure on R&D (BERD) financed by abroad, % [5]	3.0	4.7	1.6	1.2	1.0	1.0	0.9	1.2	–	–	–	1.2	10.2	27.3	96	27
Proportion of patents with foreign co-inventors, % [3]	9.2	13.2	15.3	16.0	16.0	17.2	18.4	16.7	–	–	–	16.7	24.9	47.3	65	26
R&D expenditure of foreign affiliates as a % of R&D expenditure of the enterprise, % [7] [(g)]	–	–	36.5	36.5	35.5	32.1	29.5	30.5	–	–	–	–	–	–	–	–
Net gains of skilled people through migration,'000s[8] [(f)]	–	–	29	40.4	44.2	41.1	32.2	25.2	33.6	40.2	41.0	–	–	–	–	–
Short term business trips churn, '000s[9] [(i)]	800	1057	1259	1399	1368	1226	1387	1446	1452	1463		–	–	–	–	–
Short term education trips churn, '000s[9] [(i)]	136	225	334	371	388	419	448	454	465	467		–	–	–	–	–
Short term convention and conferences trips churn, '000s[9] [(i)]	191	290	385	412	421	337	406	417	443	439		–	–	–	–	–
Short term employment trips churn, '000s[9] [(i)]	94	138	227	307	325	313	323	349	364	372		–	–	–	–	–

– = data not available

Table notes: (i) Data are presented in calendar year format. Where the data are in financial years, it is expressed in terms of the year where the financial year begins e.g. 2010–11 is shown as 2010. (ii) The 'Australia's score' field presents the Australian values used in the OECD comparisons. (iii) This is the arithmetic (simple) average of the OECD country scores. (iv) This is the arithmetic (simple) average of the top five OECD countries in a ranked list. (v) This represents Australia's distance from the frontier as defined by the average of the top five ranked OECD countries. It is calculated as 100*(Top five average - Australia's score)/ Top 5 average. Where the solution is a negative value or zero, 'no gap' is shown in the cell. (vi) OECD rankings are performed on those OECD countries for which data are available. Individual data availability may vary between indicators.

Indicator notes: (a) DHL Global Connectedness Index is calculated based on four pillars: trade, capital, information and people. (b) The figures are derived by DIICCSRTE from the OECD source based on data on exports in goods and services and GDP in billion US dollars, current prices and PPPs. (c) Exports are measured in current US$ and classified according to the Harmonised Commodity Description and Coding System (HS) 2007. The GDP used to derive the indicator is measured in US$, current prices, current exchange rates. The HS 2007 chapters selected

as a proxy for raw commodities comprise: 01: Live animals; animal products; 10: Cereals; 26: Ores, slag and ash; 27: Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes. (d) For this indicator, survey respondents were asked to answer the question 'To what extent does foreign direct investment (FDI) bring new technology into your country?' [1=not at all; 7= FDI is a key source of new technology'. (e) For this indicator, survey respondents were asked to answer the question 'To what extent do rules governing foreign direct investment (FDI) encourage or discourage it? [1=strongly discourage FDI; 7=strongly encourage FDI' (f) Net Gains of skilled persons through migration is defined as the final Net Overseas Migration (NOM) of skilled workers (i.e. permanent skilled plus temporary 457 visa holders). The latest figure is a forecast. A new method of categorising visas was introduced in May 2014. The new method assigns visas previously categorised as 'Other' to more appropriate categories, resulting in more visas being included in the category 'Skilled'. As a result, the data has been historically revised, and is not comparable to the data presented in the 2013 Australian Innovation System Report. (g) 2006 data are used in the absence of 2005 data. (h) 1994 data are used in the absence of 1995 data; 2004 data are used in the absence of 2005 data. (i) Churn values are calculated as the sum of arrivals plus departures.

Sources: [1] DHL Global Connectedness Index 2012, Deutsche Post. [2] World Bank (2014) World Development Indicators. Accessed 2014-07-01 URL: http://data.worldbank.org/data-catalog/world-development-indicators [3] OECD Factbook Statistics (OECD.Stat). [4] World Economic Forum (2013) Global Competitiveness Index. 2013-14. Accessed 2014-02-24 URL: http://www.weforum.org/issues/global-competitiveness. [5] OECD (2014) Main Science and Technology Indicators. 2013-2. [6] ABS (2012) International Trade in Services by Country, by State and by Detailed Services Category, cat. no.5368.0.55.004. [7] ABS (2013) Research and Experimental Development, Businesses, Australia, 2011–12 cat. no. 8104.0. [8] Australian Government (2014) Special data request from Department of Immigration. 2014. [9] ABS (2014) Overseas Arrivals and Departures, Australia, 3401.0.

Table 3.2 Revealed comparative advantage and export income by sector, goods exports, selected periods 1993 to 2012

Industry (ISIC Rev 3.1)	Revealed comparative advantage				Export value (US$ million)			
Goods exports	**1993–97**	**1998–02**	**2003–07**	**2008–12**	**1993–97**	**1998–02**	**2003–07**	**2008–12**
Agriculture, hunting and related service activities	3.88	4.52	3.15	2.28	37,023.6	32,861.3	35,501.2	66,175.1
Forestry, logging and related service activities	0.38	0.58	0.60	0.51	239.5	281.9	429.5	729.7
Fishing, aquaculture and service activities incidental to fishing	4.19	4.51	2.80	1.99	2,500.6	2,335.2	2,075.9	2,942.9
Mining of coal and lignite; extraction of peat	26.99	30.90	32.50	24.99	34,401.6	30,439.6	68,323.3	199,704.3
Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction, excluding surveying	1.21	1.36	1.02	1.04	13,063.6	19,827.8	37,711.9	94,632.2
Mining of uranium and thorium ores	47.92	54.93	57.88	–	960.4	1,078.2	2,133.4	–
Mining of metal ores	16.02	18.54	18.72	21.12	20,931.0	20,881.9	63,954.7	265,652.8
Other mining and quarrying	1.14	0.93	0.77	0.40	1,847.1	1,396.4	1,873.4	1,769.4
Manufacture of food products and beverages	2.44	2.62	2.45	1.33	44,782.7	39,475.3	59,564.1	75,588.6
Manufacture of tobacco products	0.12	0.21	0.42	0.29	134.7	162.6	369.5	505.2
Manufacture of textiles	0.73	0.56	0.28	0.12	7,481.6	5,076.0	3,692.6	2,708.6
Manufacture of wearing apparel; dressing and dyeing of fur	0.12	0.11	0.08	0.05	921.1	785.8	814.2	874.3
Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	0.52	0.48	0.36	0.14	2,055.5	1,640.9	1,849.6	1,534.1
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	0.79	0.87	0.97	0.73	2,913.8	2,649.9	4,474.3	5,097.0
Manufacture of paper and paper products	0.20	0.29	0.35	0.26	1,378.9	1,686.7	2,809.3	3,676.3
Publishing, printing and reproduction of recorded media	0.50	0.53	0.55	0.35	1,311.9	1,232.8	1,716.4	1,830.6
Manufacture of coke, refined petroleum products and nuclear fuel	0.51	1.11	0.67	0.32	1,300.1	6,213.0	13,870.3	19,411.7
Manufacture of chemicals and chemical products	0.39	0.43	0.42	0.29	11,467.9	12,549.3	23,150.4	34,879.3
Manufacture of rubber and plastics products	0.25	0.24	0.26	0.16	1,813.8	1,704.5	3,147.4	4,192.1
Manufacture of other nonmetallic mineral products	0.34	0.30	0.23	0.11	1,456.4	1,141.9	1,399.1	1,291.3
Manufacture of basic metals	3.86	3.82	2.92	2.17	61,845.1	52,373.8	88,462.0	147,691.8
Manufacture of fabricated metal products, except machinery and equipment	0.40	0.30	0.31	0.22	2,772.1	1,937.8	3,432.9	5,201.3
Manufacture of machinery and equipment n.e.c.	0.29	0.31	0.30	0.23	8,598.9	7,825.9	13,287.8	20,970.9
Manufacture of office, accounting and computing machinery	0.25	0.21	0.20	0.16	3,859.5	3,473.4	4,306.2	4,693.9
Manufacture of electrical machinery and apparatus n.e.c.	0.30	0.27	0.24	0.15	3,625.7	3,258.7	4,658.8	6,285.3
Manufacture of radio, television and communication equipment and apparatus	0.13	0.12	0.11	0.07	2,966.8	3,239.7	4,293.6	5,157.4
Manufacture of medical, precision and optical instruments, watches and clocks	0.28	0.49	0.49	0.36	2,625.3	4,526.7	8,173.2	13,165.7
Manufacture of motor vehicles, trailers and semi–trailers	0.23	0.33	0.34	0.18	7,179.2	10,040.1	16,700.1	15,579.0
Manufacture of other transport equipment	0.38	0.43	0.32	0.23	4,191.5	4,681.9	5,032.7	7,259.9
Manufacture of furniture; manufacturing n.e.c.	0.25	0.27	0.37	0.21	2,019.2	2,228.1	4,764.4	5,872.1

Industry (ISIC Rev 3.1)	Revealed comparative advantage				Export value (US$ million)			
Goods exports	**1993–97**	**1998–02**	**2003–07**	**2008–12**	**1993–97**	**1998–02**	**2003–07**	**2008–12**
Electricity, gas, steam and hot water supply	0.00	0.01	0.00	0.00	0.9	3.6	0.0	0.5
Other business activities	0.71	0.29	0.08	0.02	39.8	13.5	5.7	2.4
Recreational, cultural and sporting activities	0.34	0.64	0.66	0.42	143.7	256.3	445.6	479.5
Unclassified commodities	1.19	1.30	1.38	1.05	2,114.0	1,915.3	5,208.1	10,542.7

Notes: Data use International Standard Industrial Classification of all economic activities at the two-digit level.

Source: UN Comtrade Database (comtrade.un.org/).

Table 3.3 Revealed comparative advantage and export income by sector, services exports, selected periods 2006 to 2011

Services exports	Revealed comparative advantage							Export value (US$ million)						
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2007–11**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2007–11**
Transportation	0.89	0.82	0.77	0.56	0.52	0.53	0.64	6,361.4	7,244.8	7,780.9	4,298.9	4931.4	5,422.6	29,678.5
Travel	2.13	2.28	2.33	2.64	2.71	2.63	2.52	17,862.8	22,375.9	24,756.5	24,806.8	29,106.8	31,473.1	132,519.0
Communication services	0.82	0.65	0.73	0.95	0.90	0.90	0.83	640.3	598.3	778.1	948.4	1,042.0	1,163.5	4,530.4
Construction services	0.11	0.06	0.05	0.06	0.06	0.05	0.05	98.7	68.8	69.5	84.2	83.5	76.3	382.3
Insurance services	0.97	0.85	0.79	0.23	0.27	0.38	0.46	530.8	599.5	621.5	248.8	301.8	416.7	2,188.3
Financial services	0.28	0.23	0.24	0.30	0.25	0.34	0.27	757.0	856.5	888.4	967.1	892.5	1,362.6	4,967.1
Computer and information services	1.01	0.98	0.94	0.86	0.82	0.81	0.87	1,060.1	1,285.8	1,409.0	1,277.5	1,413.6	1,596.8	6,982.6
Royalties and license fees	0.25	0.23	0.21	0.22	0.24	0.24	0.23	622.7	706.9	687.8	733.1	926.5	1,049.0	4,103.3
Other business services	0.49	0.55	0.58	0.52	0.53	0.53	0.54	4,031.0	5,496.6	6,446.5	5,556.1	6,612.8	7,441.2	31,553.3
Personal, cultural, and recreational services	2.03	1.76	2.19	2.05	1.90	2.06	2.00	501.3	510.5	656.9	603.7	701.7	876.8	3,349.5

Notes: Data use Extended Balance of Payments Services Classification at the three-digit level.

Source: UN Service Trade Database (unstats.un.org/unsd/servicetrade/); Australian Bureau of Statistics (for Australia's export in 2009–2011) *International trade in services by country, by state and by detailed services category, calendar year*, cat. no. 5368055004; World Bank DataBank (databank.worldbank.org) for Australian exchange rates.

Table 3.4 The number of specialised industries (RCA>1) in selected countries

Country	Goods industries (ISIC Rev. 3, four digit)	Service industries (EBOPS 3 digit)
Australia	17	2
Brazil	34	1
Canada	44	n/a
Korea	30	2
Malaysia	28	3
Netherlands	50	5
New Zealand	35	n/a
Norway	11	n/a
Taiwan	31	2
United Kingdom	48	6

Notes: Goods data use International Standard Industrial Classification of all economic activities at the two-digit level. Services data uses Extended Balance of Payments Services Classification at the three-digit level.

Source: UN Comtrade Database (comtrade.un.org/); UN Service Trade Database (unstats.un.org/unsd/servicetrade/).

4.Value added trade and domestic supply chains

Growing international trade, global competition and greater fragmentation of production processes along global value chains fuel global collaboration on innovation. Evidence suggests that the more businesses engage in international markets, the more their performance improves.[194] McKinsey Global Institute finds that more-globally connected economies see up to 40% more benefit (in economic output) than less-connected economies.[195]

The goods and services we buy are composed of inputs from various countries around the world. However, the flows of goods and services within these global production chains are not always reflected in conventional measures of international trade. The joint Organisation for Economic Co-operation and Development – World Trade Organization (OECD–WTO) Trade in Value-Added (TiVA) initiative addresses this issue by considering the value added by each country in the production of goods and services that are consumed worldwide.[196]

4.1 Australia's participation in global value chains

Chapter 3 showed that Australia has significant competitive advantages in exporting raw commodities, basic metals, food, tourism and education-related travel with some evidence for niche areas in other sectors, such as medical technology. Seven of our top ten trading partners are in Asia. However, conventional trade statistics do not completely capture the story on Australian trade.

194 Bloom N et al. (2012) *Trade-induced technological change? The impact of Chinese imports on innovation*, diffusion of IT and productivity, National Bureau of Economic Research working paper 16717, January 2011.

195 Manyika J et al. (2014) *Global flows in a digital age: how trade, finance, people, and data connect the world economy,* McKinsey Global Institute, McKinsey & Company.

196 www.oecd.org/trade/valueadded

When we first started, it [multinational corporations, MNCs] would have been about 80% of our market. But because we expanded more and more through the promotional products area that overall reduced our reliance on the MNCs.

—Anton Pemmer, Bottles of Australia

More than 80% of Australia's exports are used by other countries to produce goods and services that are then re-exported to other markets.[197] Using input–output databases from around the world, it is possible to track not only the initial destination of Australia's exports but also the final destination of our intermediate[198] exports and the indirect contribution of Australia's domestic, non-exporting sectors to trade. This method is called 'value-added trade'.[199] Value-added trade data show that the United States (US) and Europe are more important to Australia than conventional trade statistics imply, because Australian products are indirectly exported there via Asia. It also shows that measuring gross exports alone underestimates the significant indirect contribution that business services make to Australia's international competitiveness.[200] Atkinson and Ezell[201] argue that international competitiveness can be measured by a country's ability to export more in value-added terms than it imports after controlling for terms of trade, subsidies and tariff barriers.

Since Australia has very low tariff barriers and reasonably open, transparent border regulation, we can use the TiVA database to show Australia's competitive trade strengths (Figure 4.1). The data reinforce earlier findings about Australia's comparative strength in primary industries, the manufacturing of basic metals and food, tourism and education (shown as other services). However, it also shows some hidden strengths in business services, transport and telecommunication, and some sectors with potential such as construction, utilities and financial intermediation, which have close to zero trade surpluses.

197 Kelly G & La Cava G (2014) *International trade costs, global supply chains and value-added trade in Australia,* Reserve Bank of Australia, RDP 2014-07, Canberra.

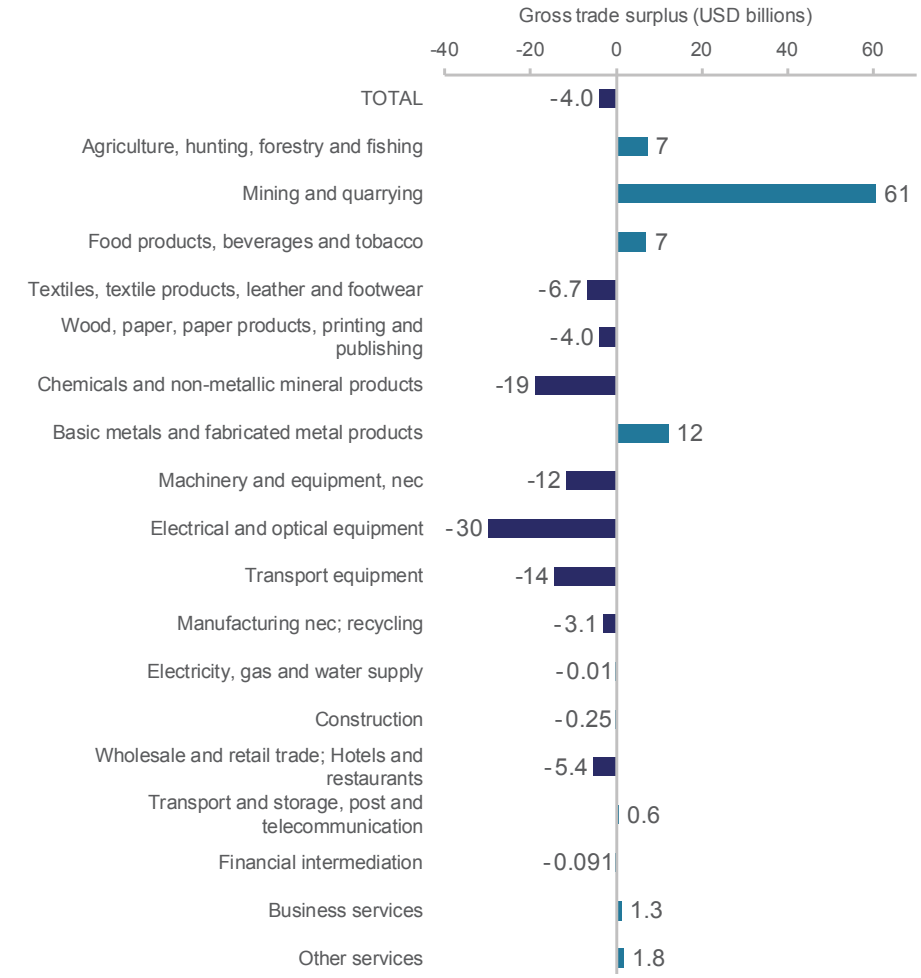
198 Intermediates are goods and services that form components of another good or service and are therefore embodied in another business/country's exports.

199 The OECD and WTO set of Trade in Value-Added (TiVA) indicators is based on the OECD Inter-Country Input–Output (ICIO) Database. The theory for developing such indicators is well established. The main challenge is data availability and the need to create balanced matrices of international flows of trade in goods and services that are consistent with official National Accounts. Reported exports by country A to country B often do not match reported imports by country B from country A. The global balancing of the ICIO essentially removes inconsistencies, but resulting bilateral gross trade flows may not match some countries' perceptions of their trading patterns.

200 Kelly G & La Cava G (2014) *International trade costs, global supply chains and value-added trade in Australia,* Reserve Bank of Australia, RDP 2014-07, Canberra.

201 Atkinson RD & Ezell SJ (2012) *Innovation economics: the race for global advantage,* Yale University Press, New Haven.

Figure 4.1 Australia's gross trade surplus in value-added terms, by industry, 2009



Source: OECD-WTO Trade in Value-Added (TiVA), May 2013.

Value-added trade data can also be used to measure a country's participation in global value chains. Global value chains are production networks that span multiple countries, with each country specialising in a phase or component of the final product.[202] [203] A global value chain occurs when globally dispersed partners decide to collaboratively innovate to create and deliver value for which their customers and consumers will pay a premium price.[204]

The manufacture of the Boeing 787 Dreamliner aeroplane and the Apple iPhone are good examples of global value chains in action.[205] Of all global trade, 70% is now in intermediate goods and services and capital goods,

202 Porter ME (1985) *Competitive advantage,* Free Press, New York.

203 These activities include the primary activities of inbound logistics; operations, outbound logistics, marketing and sales; and services and support activities such as procurement, technology development, human resources management and firm infrastructure.

204 Bonney L & Ayala S (2013) *Collaborative innovation in global supply chains,* University of Tasmania, Hobart, horticulture.com.au/librarymanager/libs/19/Laurie%20Bonney.pdf.

205 De Backer K & Miroudot S (2013) Mapping global value chains, *OECD Trade Policy Papers* 159:47.

rather than end products driving a shift in competition for high-value, niche intermediate goods and services.[206]

There is also growing international evidence that innovation is necessary to drive and sustain global value chain participation.[207] Global value chains allow lead companies to access the best capabilities anywhere in the world for the best price. A country's integration into global value chains can therefore represent a measure of its international competitiveness for a particular good or service.[208]

Australia's integration in the global economy can be measured by seeing how much foreign value-added sustains both Australia's domestic demand and its exports. By this measure Australia appears to have a low degree of integration into the world economy, consistent with our relatively low level of trade as a percentage of gross domestic product (GDP) (Figure A.20).

Backward participation measures the value of imported inputs in the overall exports of a country (the remainder being the domestic content of exports). This indicator provides an indication of the contribution of foreign industries to the exports of a country by looking at the foreign value-added embodied in the gross exports. Forward participation is the share of exported goods and services used as imported inputs to produce other countries' exports. This indicator gives an indication of the contribution of domestically produced intermediates to exports in third countries.

The domestic value-added content of Australian exports sits at 87%—the second highest among OECD economies.[209] However, there are a number of factors affecting a country's position in this indicator. Large economies like the US and Japan tend to have higher domestic value-added content in their exports. Countries with relatively open and liberal trade regimes and high levels of foreign investment will typically have more foreign content in both their exports and their domestic consumption.[210]

Australia bucks both these trends. Economies, like Australia, that specialise in activities at the beginning of the value chain (upstream), such as mining and agriculture, or specialise in services or are geographically distant from

206 *Livingstone C (2014) Vision for a competitive Australia, speech to the Australia–Israel Chamber of Commerce lunch, 28 July 2014.*

207 De Backer K & Miroudot S (2013) *Mapping global value chains*, OECD Trade Policy Papers 159:47, p. 43.

208 OECD (2013) *Science, technology and industry scoreboard 2013*, OECD Publishing, p. 224.

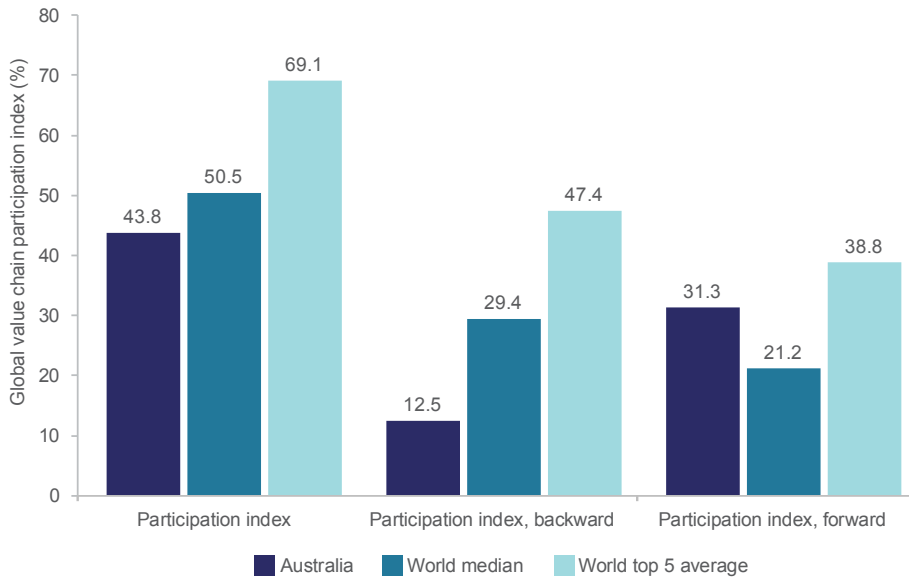
209 OECD–WTO (2013) Trade in Value-Added (TiVA) Database, stats.oecd.org/Index.aspx?DataSetCode=TIVA_OECD_WTO.

210 OECD (2013) *Science, technology and industry scoreboard 2013,* OECD Publishing.

foreign markets and suppliers, tend to have higher domestic (and lower foreign) value-added content in their exports than others.[211]

According to the OECD's global value chain participation index, Australia's overall participation in global value chains is below the OECD median and well behind global value chain hub countries (Figure 4.2). Australia's forward participation is above the OECD median and our backwards participation below the OECD median, but our participation has improved since 1995. This reflects an increasing emphasis on the export of raw commodities and a heavier reliance on domestic suppliers of intermediates for the production of more complex products.[212]

Figure 4.2 Australia's relative global value chain participation, 2009



Notes: The indicator is expressed as the share of foreign inputs (backward participation) and domestically produced inputs used in third countries' exports (forward participation) in a country's gross exports. Further details can be found in the OECD Trade Policy Paper No. 159.

Source: OECD (2013) Global value chains indicators.

Figure 4.3 breaks down global value chain participation by sector. In sectors where Australia has distinct competitive advantages, our global value chain participation is above the OECD median—for example, in agriculture, mining, business services, transport and telecommunication, and manufacturing of basic metals and food (Figure 4.3).

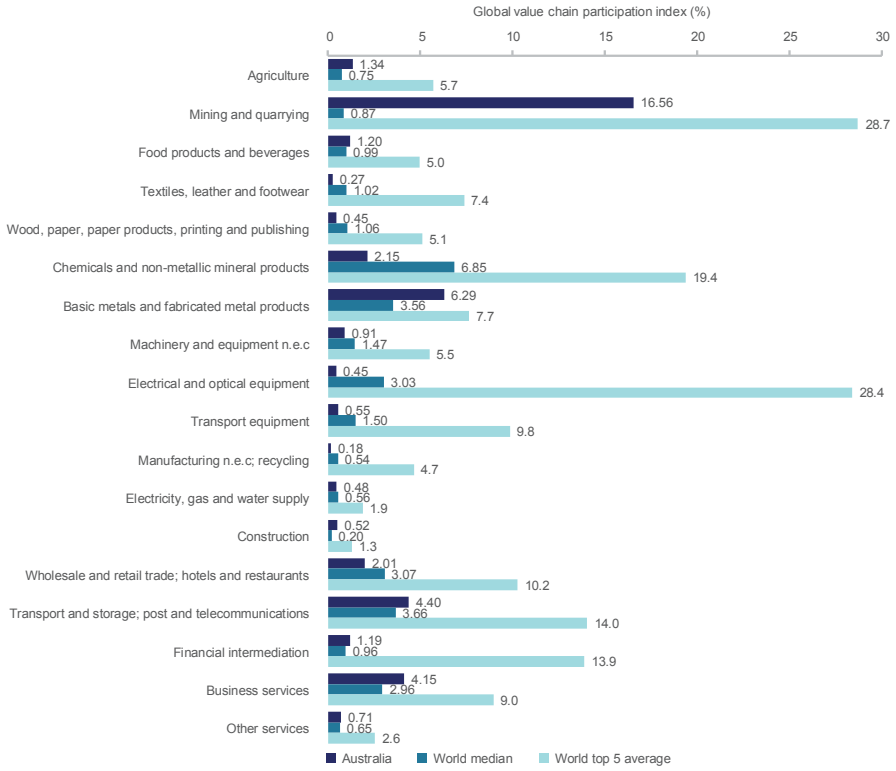
The sectoral breakdown of Australian exports in value-added terms also shows us the sectors indirectly contributing to or benefiting from trade (Figures 4.1 and 4.3). Services exports account for a much higher share of Australia's exports in value-added terms (41%) than in gross terms (22%).

211 Ibid. p. 250.

212 OECD (2013) *Science, technology and industry scoreboard 2013,* OECD Publishing, p. 224.

By contrast, the manufacturing sector comprises a much smaller share of Australian value-added trade (21%) than of gross trade (40%).[213]

Figure 4.3 Australia's relative global value chain participation, by industry, 2009



Source: OECD global value chains indicators, May 2013.

Businesses that participate in global value chains have been argued to be more innovative, more engaged in research and development (R&D) and skills development, drive the highest productivity premium, and can support high unit labour costs.[214] Participation in global value chains also drives a step change in business culture by challenging participants to upgrade their management, financing and technology, and encourages greater collaboration. This in turn helps them improve their productivity.[215] [216]

The most value creation in a global value chain is often found in innovative upstream activities, such as the development of a new design, R&D, or the manufacturing of key parts and components, or in downstream activities, such as marketing, branding or customer service.[217] In many developed economies, more than half of value-added is associated with service activities like transportation, logistics, finance, insurance and communications.[218] Australia can therefore move up the value chain not

213 Kelly G & La Cava G (2014) *International trade costs, global supply chains and value-added trade in Australia*, Reserve Bank of Australia, RDP 2014-07, Canberra.
214 OECD (2013) *Drawing the benefits of global value chains,* OECD Publishing.
215 OECD (2008) *Enhancing the role of SMEs in global value chains,* OECD Publishing, p. 3.
216 OECD (2013) *Drawing the benefits of global value chains,* OECD Publishing.
217 Ibid., p. 13.
218 Ibid.

just by moving into high-value niche intermediates, but also by engaging in high-value activities like R&D, design, marketing, financial and legal services within various sectors.[219] Investing in research and innovation will be the key to maintaining a strong position in a global value chain as a price maker.[220]

The OECD argues that governments can support the participation of small and medium-sized enterprises (SMEs) in global value chains by encouraging the development of linkages with international firms, fostering their supply capacity and ability to innovate, and facilitating the adoption of the best international product standards.[221]

Box 4.1 shows an example of how an Australian company contributes to a global value chain.

In the beginning [of starting the company], the links with the multinationals legitimised who we were.

—Anton Pemmer, Bottles of Australia

Box 4.1 Case study: Bottles of Australia[222]

When you think of bottles, you don't normally think of innovation or Australia's image and comparative advantage, but that is one of the secrets behind the growth of Bottles of Australia (BOA).

BOA started in 1989 in the bicycle industry, importing BMX stickers. Cyclists need to carry water with them in bottles to keep them going, as does everyone who engages in healthy outdoor activities. This is how BOA morphed into a company that specialises in custom-printed drink bottles.

BOA's success is not all that surprising since Australians' value-add to niche manufacturing is often at the very beginning of the value chain—in design innovation. BOA also capitalises on that other notable aspect of Australian innovation—lifestyle, health and our love of the great outdoors.

Water bottles are a low-tech item, but this doesn't mean that they are low value for their Australian manufacturers/designers or for their customers. BOA has become the leading sports drink bottle manufacturer in Australia. According to BOA Director Anton Pemmer, 'it is the dominant player in the middle to upper end of the Australian sports drink bottle market'.

Innovation has been a constant need to stay ahead in the business. In the 1990s, the uniqueness of being the only Australian-produced bicycle water bottle was enough. But since 2000, BOA has had to constantly innovate to stay ahead of the competition, particularly from foreign competitors who imitate their products. Design innovation is particularly important. New designs attract a new and broader

219 OECD (2013) *Interconnected economies: benefiting from global value chains,* OECD Publishing, p. 4.

220 ACOLA (2014) *The role of science, research and technology in lifting Australian productivity,* Securing Australia's future Project 4 final report, p. 42, www.acola.org.au.

221 OECD (2013) *Interconnected economies: benefitting from global value chains,* OECD Publishing, p. 4.

222 Interview conducted 2 April

customer base, as well as renew old customers. Anton emphasises, 'we are a market leader rather than a follower; we have a big advantage from early market entry and design'.

What percentage of sales will be due to a new product? According to Anton, 'within the first year, new products would be, at most, 5% of total sales, but in 18 months to two years those new products will step up to each be 20–25% of our sales'.

Print production process

Bottles sorted and loaded automatically

Innovation is not confined to product design. It extends to manufacturing and logistics, as well as to marketing and branding. 'We don't want design to be limited by the current manufacturing process', he says.

Facing a tough market in the past two years, Anton undertook rebranding exercises for his company and redeveloped the BOA website. Reflecting on this decision, he says 'innovation comes not just from the product but the look and feel of the company. The rebranding took us right up to date'.

The BOA relationship with the multinational corporations is also important. It sees about 25–30% of its products sold through corporations like Asics, Puma, Adidas, Giant Bicycles, Shimano and Warner Brothers. For them, BOA offers a consistent reliable supply, and is equipped to service companies that want faster deliveries and/or lower volumes for special events.

Anton has one final remark about offering value in the marketplace. 'The best advice I ever got was that your customer should never have to pay for your inefficiencies', he says.

4.2 Who are the suppliers of Australian exporters?

Many sectors of the economy supply most of their output to other Australian businesses (Table 2.2).[223] SMEs generate 58% of the value-add to products in Australia. This raises questions such as:

- Who are the suppliers of Australian exporters?
- What kinds of goods and services do they supply?
- Are their innovation capabilities an important factor in sustaining the competitiveness of Australian exports and integration in global supply chains, given that large Australian firms are relatively poor performers on innovation?

223 This is derived using the Trade in Value-Added (TiVA) method, which measures the value-added by industries within each country involved in the production of a good and service.

To look at these questions it is useful to take a sectoral approach. Figure 4.4 summarises the input–output flows of three sectors of the Australian economy in three different industries: coal mining; professional, scientific and technical services; and electrical equipment manufacturing.

The value of Australian coal exports was US$33.3 billion in 2009. This sector also exhibits a level of export competitiveness indicated by its high revealed comparative advantage (RCA) value of 25 (Table 3.2). Figure 4.4A shows that the Australian coal industry requires $20.9 billion of intermediate goods and services to be able to export $33.3 billion and supply domestically $8.5 billion (mainly for electricity generation). These goods and services are supplied mainly by domestic business of all sizes, including many SMEs. For example, the exploration mining services sector, which supplies $5.8 billion in services to coal mining, is dominated by SMEs. Similarly, construction services, and professional, scientific and technical services jointly supply more than $2.3 billion in services to coal mining. In these two sectors, SMEs contribute more than 70% of the total value-added.[224] Some of the service sector firms supplying coal mining are highly knowledge and R&D intensive (see Table 2.2).

The input–output structure for the professional, scientific and technical services sector, also a domestic-oriented sector, is shown in Figure 4.4B. The sector supplied $126 billion to the domestic market in 2009 and exported $6.1 billion. This sector is reasonably self-sufficient (about 19% of the input required by this sector comes from the same sector), as firms within the sector rely on their expertise and networks to do their business. For example, an engineering firm undertaking an industrial project may require services of another specialised engineering firm or a consulting firm specialised in environmental services. This sector shows one of the highest rates of collaboration on innovation among Australian industry (25% of the businesses in the sector collaborate for innovation purposes). It is also the biggest R&D spender in Australia ($3.2 billion; Table 2.2). The sector faces a small degree of international competition (imports) to the value of $4.5 billion in 2009.

The electrical equipment manufacturing sector (Figure 4.4C) is a smaller sector, both in terms of exports and supply to the domestic economy, compared with the other two sectors covered. The RCA values for this sector are low, as with most of manufacturing (with the exception of food and basic metal manufacturing), which means that Australia exports less than the world average in these sectors. Data that show, for example, low export intensity but high R&D intensity and levels of innovation indicate that this sector may have an innovative capacity that allows it to compete locally but not internationally. This sector, like a lot of manufacturing, experiences significant import competition. Electrical equipment imports competing for the domestic market amounted to $6.6 billion in 2009. This is of significant scale compared to domestic production of $10.7 billion. High import competition faced by manufacturing is further discussed in Appendix B.

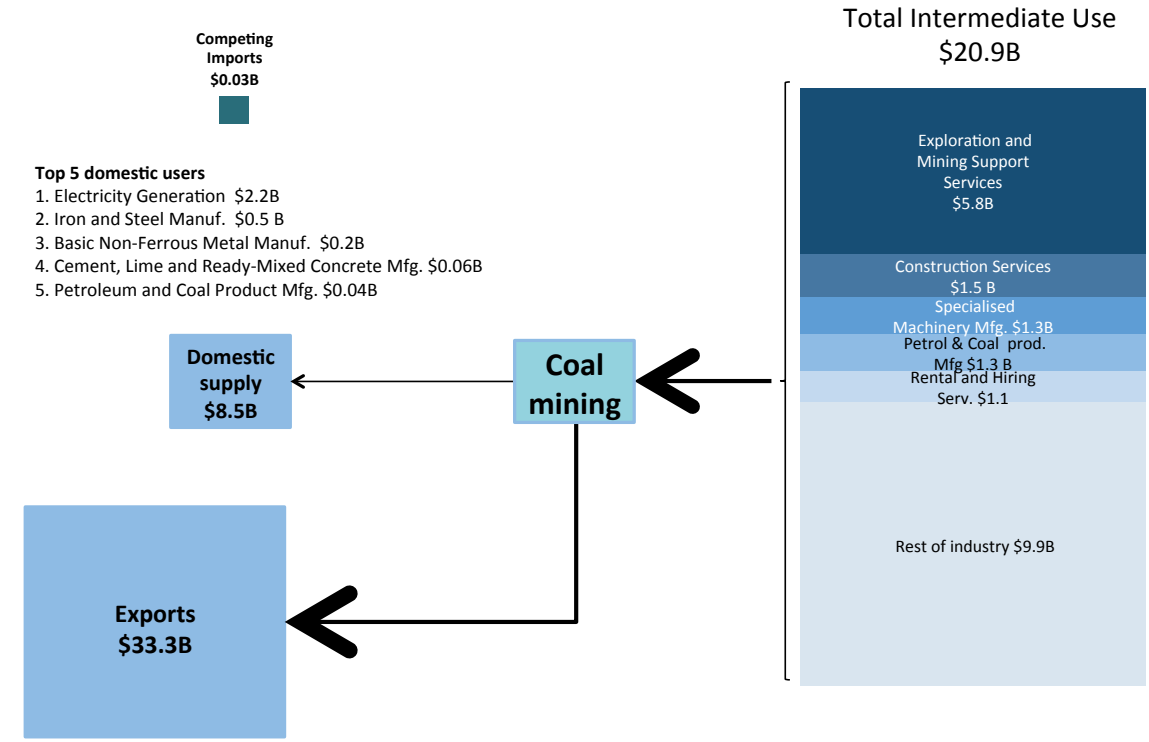
We use a variety of different freight companies and drivers, and we'll interchange to make sure that the particular infrastructure, both third party and internal, that we use is perfect for the customer. The supply chain we have in place in the Sunshine Coast will look very different to the one we have in place in CBD Sydney.

—Michael Drummond, Di Bella Coffee

224 ABS (2014) *Australian industry, 2013–14,* Table 5: Business size by industry division, data cube: Excel spreadsheet, cat. no. 8155.0, ABS, Canberra.

Figure 4.4 **Flows of industry use output by final use and intermediate supply by sector for coal mining (A); professional, scientific and technical services (B); and electrical equipment manufacturing (C), 2009–10**

A. Coal mining



B. Professional, Scientific and Technical Services

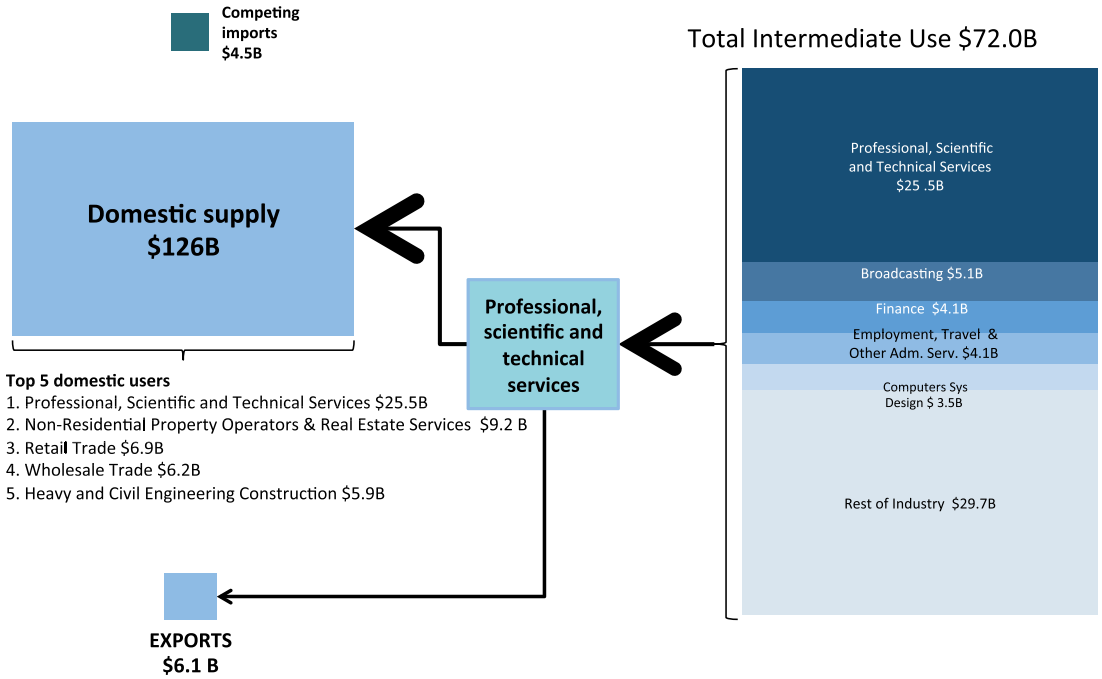
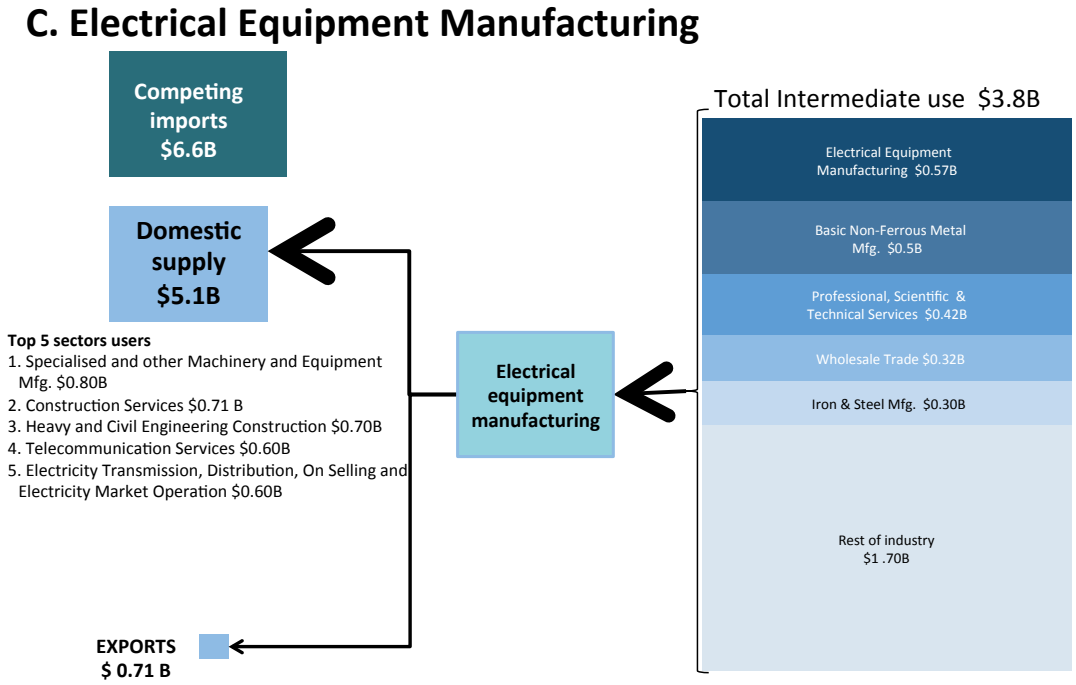


Figure 4.4 **Flows of industry use output by final use and intermediate supply by sector for coal mining (A); professional, scientific and technical services (B); and electrical equipment manufacturing (C), 2009–10**



Source: ABS (2013) Australian National Accounts: input-output tables, 2009-10, cat.no. 5209.0.55.001

5. Collaboration and competitiveness

Collaboration is a powerful tool for businesses to increase their level of innovation, especially world-first innovation. Collaboration also substantially increases the likelihood of engaging in exporting activity, particularly for small to medium-sized enterprises (SMEs).

Although some sectors in Australia appear to perform better than others, Australian businesses generally have among the lowest levels of collaboration for innovation in the Organisation for Economic Co-operation and Development (OECD) and appear to have a low ability to absorb and exploit external information that might improve their competitiveness. The absorptive capacity of Australian businesses may be limited by low concentrations of researchers in business and a highly uneven distribution of researchers within the private sector.

5.1 Why is collaboration on innovation important?

Firms do not develop either competitive productivity advantages or innovation capabilities in isolation from each other.[225] Highly networked innovation systems enable businesses to share resources, risk and ideas for innovation.[226] International business-to-business collaboration on innovation provides a mechanism for sourcing the widest possible range of ideas and resources to build a firm's competitiveness. Businesses that pursue a culture of both innovation and collaboration experience compounding benefits across a range of business performance measures.[227]

Collaboration is defined as the arrangement where businesses work together for mutual benefit, including some sharing of technical and commercial risk.

225 Enright MJ & Petty R (2013) *Australia's competitiveness: from lucky country to competitive country*, CPA, John Wiley & Sons, Singapore, p. 27.

226 OECD (2010) *The OECD innovation strategy: getting a head start on tomorrow,* OECD Publishing; ACOLA (2014) *The role of science, research and technology in lifting Australian productivity,* Securing Australia's future Project 4 final report, www.acola.org.au; Microsoft Australia (2014) Joined-up innovation, discussion paper, www.microsoft.com/enterprise/en-au/business-leaders/joined-up-innovation/default.aspx.

227 Vinding AL (2006) *Absorptive capacity and innovative performance: a human capital approach,* Economics of Innovation and New Technology 15:507–17.

Collaboration with a partner can tap into a different sector of the audience.

—Timothy Calnin, Australian Chamber Orchestra

At our innovation and entrepreneurship boot camp, we invite researchers along to understand lean start-up methodology and industry collaboration, and addressing problems in the market and not having this focus on producing a white paper.

—Craig Hill, Australian Sports Technology Network

Each participant in the collaboration does not need to benefit commercially. From all businesses, the Australian Bureau of Statistics (ABS) collects the type of collaborative arrangement businesses were involved in and, for innovation-active businesses, whether that collaboration was for innovation purposes, and if so, the type of organisation they had collaborated with and the location of that organisation.

Collaboration can be motivated by diverse aims and therefore involve a broad spectrum of activities. Firm may collaborate to solve complex problems and think outside the box; share knowledge, material resources and risk; build skills and other capabilities; stay abreast of new developments; or expand their market reach and achieve economies of scale.[228] Collaboration therefore increases the scope and ambition of what a single business might otherwise achieve by acting alone, and this lends itself to more innovative kinds of activity.

In 2012–13, 20.3% of innovation-active firms collaborated on innovation; this proportion has grown from 17% in 2005–06 (Table 5.1). Large firms were more likely collaborate on innovation, with 32.3% reporting this in 2012–13 whereas only 20.1% of SMEs did so. Businesses may collaborate for purposes other than innovation: 14.0% of innovation-active businesses reported collaborating for any reason, against just 4.6% of non-innovation-active businesses.

Collaboration between businesses and research organisations such as CSIRO is also particularly important, as it more than triples the likelihood of business productivity growth and significantly improves other performance measures.[229] Collaboration with research organisations is strongly correlated with the degree of innovation novelty; firms engaged in such collaboration are more likely to introduce world-first innovations.

Research collaboration is important not just for the creation of new products and processes, but also for keeping up with the rest of the world's state of the art in technology, business models and practices.

5.2 The link between innovation, exporting and collaboration

ABS data show that exporting SMEs are three times more likely to collaborate for any reason than firms focused on domestic markets. Large exporters are also 28% more likely to collaborate than other large firms.[230]

Figure 5.1 disaggregates these general collaboration results even further. Businesses can collaborate on a range of tasks, not just innovation. These arrangements can include joint marketing, joint purchasing and supply chain cooperation. Innovation-active businesses are three times

228 Department of Innovation, Industry, Science, Research and Tertiary Education (2012) *Australian Innovation System Report 2012,* Canberra, p. 64.

229 See the *Australian Innovation System Report 2013,* Canberra, p. 53, www.innovation.gov.au/aisreport.

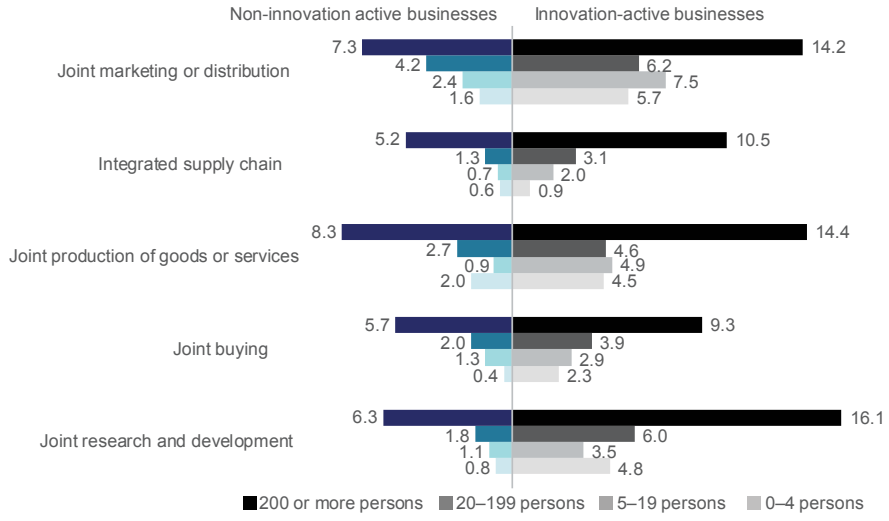
230 ABS (2014) Department of Industry customised data request based on the Business Characteristics Survey.

more likely to collaborate for any reason than their non-innovation-active counterparts (Table 5.1). Collaborative arrangements such as joint research and development (R&D) and supply chain integration are significantly correlated with innovation (Figure 5.1).

Exporting firms' collaborative partners are substantially different to those of collaborating, domestically focused firms. Innovative, exporting SMEs are significantly more externally oriented compared with non-exporting counterparts (Figure 5.2). Exporting firms are less likely to collaborate within their business group and more likely to engage with research organisations domestically (Figure 5.2A). This appears to be a specific SME strategy for international competitiveness. Exporting businesses are also more likely to collaborate with a range of partners internationally (Figure 5.2B).

Figure 5.1 Collaborative arrangements, by innovation status, by employment size, 2012–13

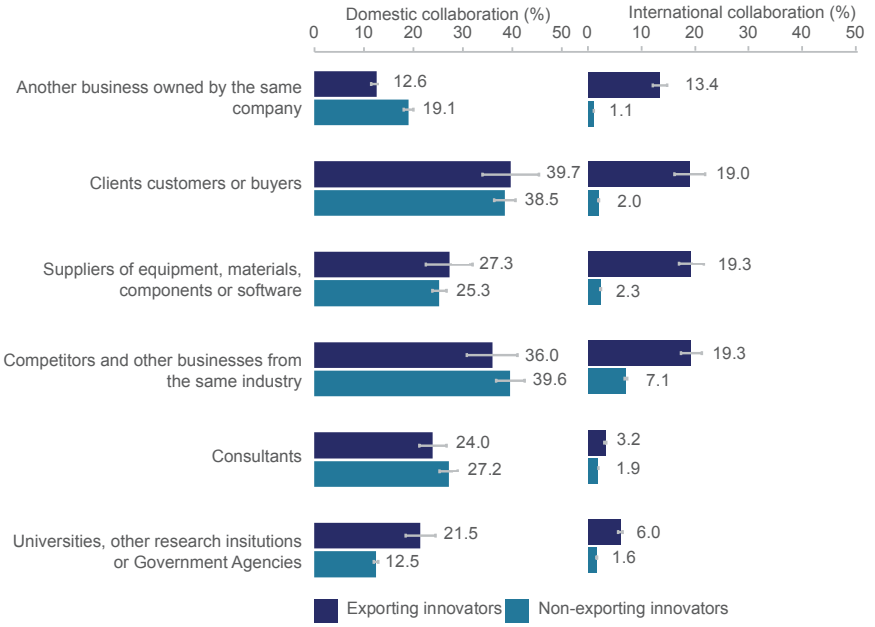
Source: ABS (2013) Selected characteristics of Australian business, 2011–12, cat. no. 8167.0, ABS, Canberra.



To preserve and protect our brand we can really only partner with people that we know can protect it … we collaborate with people that are aligned with our philosophy.

—Michael Drummond, Di Bella Coffee

Figure 5.2 Small to medium-sized enterprise partners for domestic and international collaboration on innovation, by export status, 2010–11



Source: ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

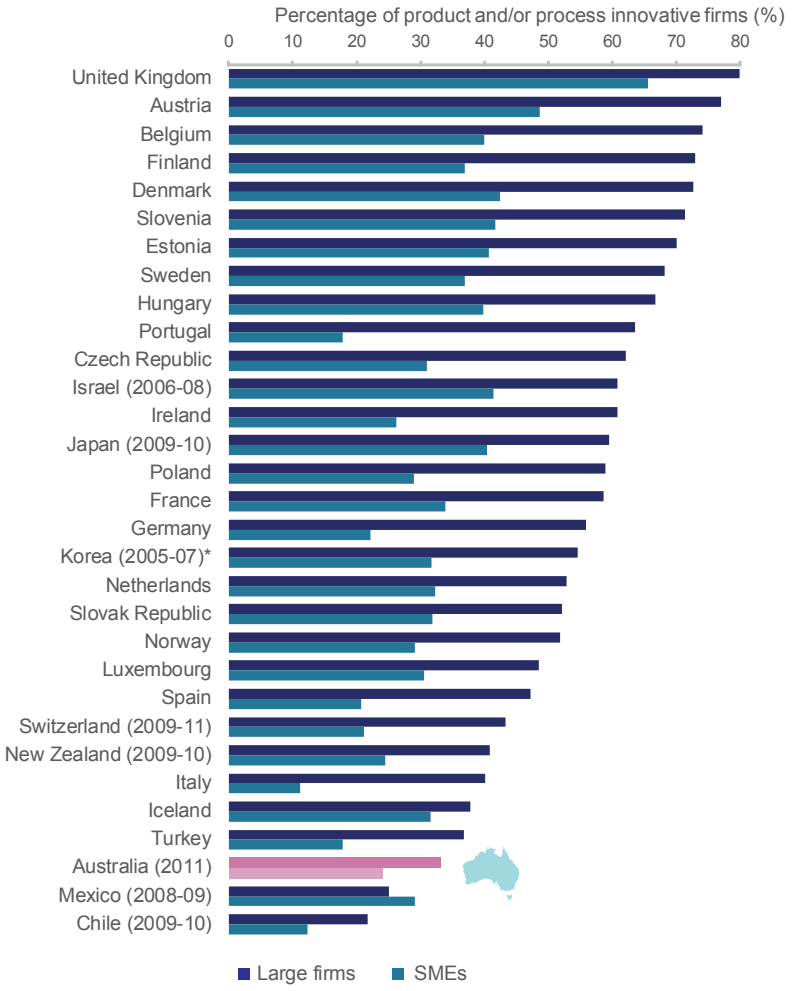
On the other hand, large, innovative exporting businesses are less likely to partner with research organisations domestically, and more likely to partner with businesses within their group and/or with customers and clients (Figure A.21A). Compared with their non-exporting, innovative counterparts, large innovative exporters are more likely to collaborate internationally (Figure A.21B). The difference between exporting and non-exporting firms' tendencies to collaborate on innovation appears to have diminished since 2006–07.

5.3 Australia's collaboration on innovation relative to other countries

Between 2006–07 and 2012–13, collaboration on innovation has remained low for SMEs and large firms have increased by 47% during the same period (Table 5.1). However, Australia continues to rank near the bottom of the OECD on all types of collaboration on innovation. Australia was ranked 24th out of 31 OECD countries in 2008–10 for SMEs and 29th for collaboration on innovation by large firms. Only 6.1% of innovation-active firms collaborate internationally (Table 5.1).

The performance of Australian businesses on international collaboration more broadly varies slightly by firm size (Figure 5.3). Large firms rank 27th on international collaboration and SMEs rank 25th out of 27 OECD countries.

Figure 5.3 Firms collaborating on innovation activities, by size, 2008–10



Notes: For Australia, data refer to financial year 2010–11 and include product, process, marketing and organisational innovative firms (including ongoing or abandoned innovation activities) only.

**Refers to Korean manufacturing sector only.*

Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013.

There is a structural relationship between internationalisation, exporting and innovation.[231] Australian businesses' low levels of international collaboration on innovation may therefore be a consequence of their low levels of trade. This is supported by the fact that, in contrast to our performance on international collaboration, Australia's domestic collaboration performance (18.1%) is above the OECD average, ranked 9th.[232]

231 ACOLA (2014) *The role of science, research and technology in lifting Australian productivity,* Securing Australia's future Project 4 final report, p. 85.

232 OECD (2013) *Science, technology and industry scoreboard 2013,* OECD Publishing, based on Eurostat (CIS-2010) and national data sources.

The 'tyranny of distance' alone cannot explain Australia's low international collaboration on innovation. Other countries that are distant from the major markets of western Europe and North America—such as Israel, South Africa and New Zealand—are more active in international collaboration on innovation than Australia (Figure A.22) and more integrated into global value chains.[233]

Business collaboration has a significant and positive association with new-to-market innovation. For example, business collaboration on innovation is associated with a 70% increase in the likelihood of new-to-world innovation and a 32% increase in the likelihood of new-to-Australia innovation.[234] Poor collaboration on innovation is therefore likely to diminish Australia's ability to be a part of many world-first innovations.

Over the years we've built up really good relationships with all the car manufacturers, Toyota, Mazda, Kia, Hyundai, all of those guys. We work a lot with them now and they're coming to us with requests and suggestions, figuring out what we have available and what we can develop.

—Ben Bartlett, Lumen

New-to-world innovators are heavy users of science and research skills. Most of those skills are employed in the public sector, particularly in publicly funded research organisations. Collaboration between research organisations and industry in Australia is one of the lowest in the OECD. Industry-research collaboration on innovation by Australian SMEs is ranked 29th out of 30 OECD countries and large firms are ranked in 30th position (Figure A.23).[235]

With their high innovation propensity by OECD standards, Australian SMEs have the potential to collaborate and engage in more world-first innovation and global supply chain participation. Given the strong association between collaborative innovation and exporting, businesses, researchers and governments should be looking to ways of fostering greater links.

More systemic strategies may be needed to encourage the innovation system to function more effectively, such as encouraging a management culture shift in Australian firms to one of external orientation and providing stronger incentives for the university sector to engage with industry.[236]

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233 Australian trend data suggests a marginal improvement in large firm collaboration on innovation between 2006–07 and 2013–14. SMEs show a decline in collaboration on innovation in the latest year. Caution is needed in interpreting this decline, given data on collaboration are highly volatile. Levels of collaboration on innovation vary significantly across different sectors, but it is difficult to determine specific trends because ABS sectoral innovation data on collaboration have high variation or cannot be published.

234 Australian Government Department of Industry, Tourism and Resources (2006) *Collaboration and other factors influencing innovation novelty in Australian businesses: an econometric analysis,* Canberra, www.industry.gov.au/innovation/reportsandstudies/Pages/CollaborationandInnovationNovelty.aspx.

235 OECD (2013) *Science, technology and industry scoreboard 2013,* OECD Publishing, p. 127.

236 ACOLA (2014) *The role of science, research and technology in lifting Australian productivity,* Securing Australia's future Project 4 final report, p. 42, www.acola.org.au; Lydon J et al. (2014) *Compete to prosper: improving Australia's global competitiveness,* McKinsey Australia; and Microsoft Australia (2014) *Joined-up innovation, discussion paper,* www.microsoft.com/enterprise/en-au/business-leaders/joined-up-innovation/default.aspx.

5.4 Absorptive capacity and intermediaries

A business' ability to identify, absorb, transform and exploit external knowledge[237]—that is, its absorptive capacity —is an important way to achieve superior innovation and financial results over time.[238]

A recent unpublished Australian Government Department of Industry survey of 650 Australian businesses across Australia found that businesses that reported high levels of absorptive capacity significantly outperformed businesses with low absorptive capacity in almost all performance measures, [239] including market share growth, employee productivity, the percentage of revenue from exports, the percentage of revenue from new goods and services, and the extent of world-first innovation.[240] Many intangible capital investments such as R&D, skills development, collaboration, and systems and processes for disseminating knowledge throughout an organisation are important for building the absorptive capacity of an organisation. Design and engineering expertise are also important for building the absorptive capacity of a business.[241] Engineers are vital to convert innovative ideas into a technological and market reality.[242]

The more a firm invests in R&D activities, the better it will be at adopting innovations and deriving profit from these activities.[243] 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 full-time equivalent (FTE) personnel per thousand employment in industry was 7.6 in 2011.[244] Australia ranks 19th out of 32 countries on this measure. The Australian figure is below the OECD average of 9.6 and well behind the top five OECD countries' 18.5. Although relatively low, Australia has grown at an average annual compound growth rate of 5.1% in the past 30 years from a low base of 1.6 business R&D FTE personnel per thousand employment in industry in 1981. The total number of business researchers (FTE) per thousand employment in industry was 3.8 in 2011.[245] Australia ranks 21st out of 34 countries on this measure. The Australian figure is below the OECD average

237 Zahra SA & George G (2002) Absorptive capacity: a review, reconceptualization and extension, *Academy of Management Review* 27(2):185–203.

238 Kostopoulos K et al. (2010) Absorptive capacity, innovation and financial performance, *Journal of Business Research* 12:1335–43.

239 This work was partly done in collaboration with the Melbourne Institute for Applied Economic and Social Research.

240 Department of Industry, unpublished research.

241 Scott–Kemmis D et al. (2007) *Absorbing innovation by Australian enterprises: the role of absorptive capacity,* Department of Industry, Tourism and Resources, Canberra.

242 See *Innovation in Engineering report* p. 4, www.engineersaustralia.org.au/sites/default/files/shado/Representation/Research_and_Reports/innovation_in_engineering_report_june_final_web.pdf

243 Cohen WM & Levinthal DA (1989) Innovation and learning: the two faces of R&D, *The Economic Journal* 99:569–96; Guellec D & van Pottelsberghe de la Potterie B (2001) R&D and productivity growth: panel data analysis of 16 OECD countries, *OECD Economic Studies* 33, OECD Publishing; and Griffiths W et al. What creates abnormal profits? *Scottish Journal of Political Economy* 58(3):323–46.

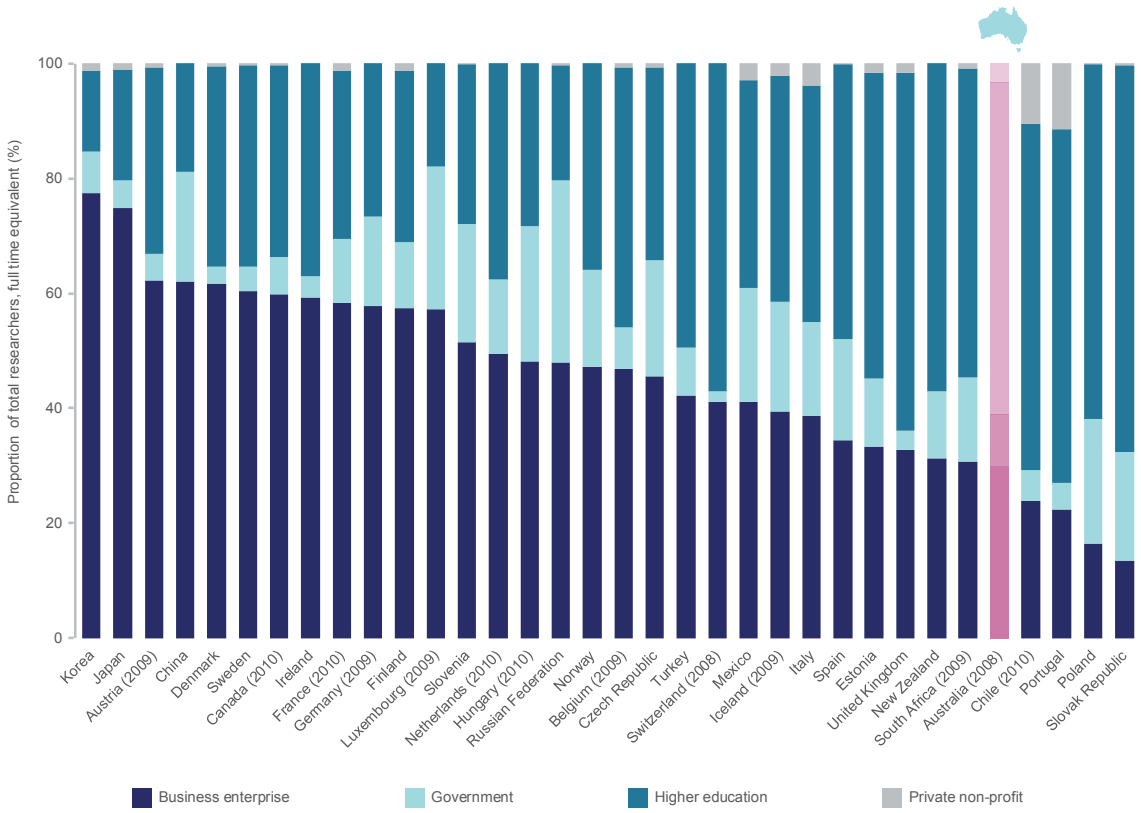
244 OECD (2014) *Main science and technology indicators.*

245 Ibid.

of 5.8 and well behind the top five OECD countries' 13.0. Figure 5.4 also shows that Australia has a low proportion of its total researchers in the business sector (31%) by OECD standards, where the proportions range between 13% and 77%. Australian researchers are predominantly working in the higher education sector.

This low absorptive capacity in business may mean that businesses undervalue 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 firms in Australia, as R&D investment is unevenly distributed. Out of the 2 million businesses in Australia, only around 9000 businesses undertake R&D—less than 0.5%. Even then, the majority of total business R&D investment, which is below the OECD average, is highly skewed to a few large firms that invested 66% of the total $18.1 billion in business R&D in 2010–11.

Figure 5.4 Researchers by sector of employment, 2011



Source: OECD (2013) Research and Development Statistics Database, www.oecd.org/sti/rds.

The absorptive capacity of Australian businesses may be further limited a highly uneven distribution of researchers within the private sector. Figures 5.5 and 5.6 demonstrate that engineering and PhD graduates are highly concentrated within a few sectors of the economy. Many private industry

sectors employ very low percentages of PhD graduates, with the majority of them filling management or technical roles in their sector of employment.

Not surprisingly, the professional, scientific and technical services sector has a high concentration of both engineering and PhD graduates. In the case of engineering graduates this sector has almost double the percentage of graduates as manufacturing. Professional, scientific and technical services sector intermediate inputs are, however, widely distributed to the domestic economy. Almost 20 other subsectors each consume more than $1 billion worth of professional, scientific and technical services.[246] Unlike other sectors of the economy, R&D investment is much more evenly spread across firms in the professional, scientific and technical services sector (medium-sized firms spend 40% of the total R&D investment for that sector). ABS data suggest that this sector had the highest level of world-first innovation (21.7%; see also Figure A.5).

Business collaboration on innovation with consultants (who are highly concentrated in the professional, scientific and technical services sector) is significantly higher than collaboration with universities and other higher education institutions (Figure A.24). This characteristic of business collaboration in Australia can also be seen in the data on the sources of ideas for innovation, which show that the consulting sector is more influential and connected to other industries than the research sector.[247] Therefore, the professional, scientific and technical services sector seems very well positioned to support the diffusion of knowledge and research expertise from the public research sector (including both universities and publicly funded research agencies) to other sectors of the Australian economy.

Some best-practice examples of knowledge-intensive intermediary organisations such as the InnovationXChange (IXC)[248] and ATP Innovations[249] originated in Australia. These organisations are not only facilitating the development of new products and services, but also changing the innovation culture in the business sector.

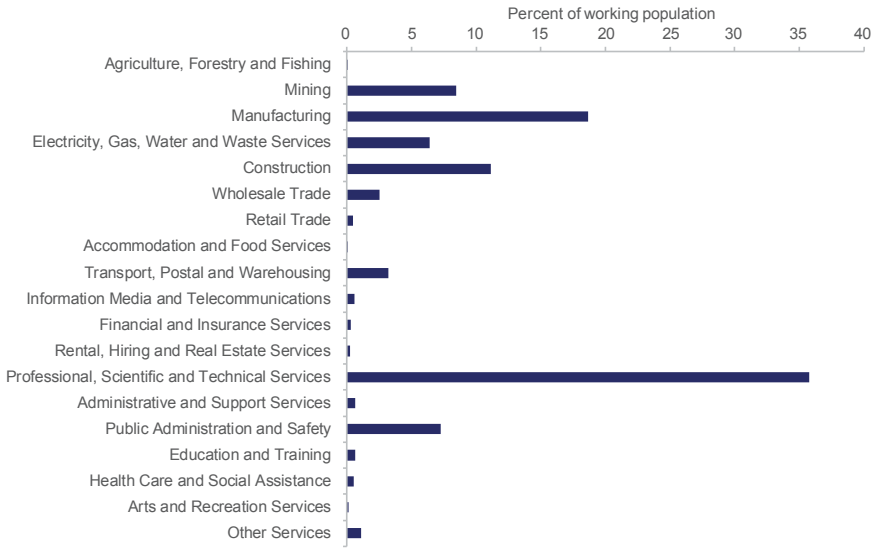
246 ABS (2013) *Australian national accounts: input-output tables—2009–10,* Table 2 Input by industry and final use category and supply by product group, cat. no. 5209.0.55.001, ABS, Canberra.

247 ABS (2014) *Innovation in Australian business,* 2013–14, cat. no. 8158.0, ABS, Canberra.

248 Bell J et al. (2014) *The role of science, research and technology in lifting Australian productivity,* report for the Australian Council of Learned Academies (ACOLA), p. 78, www.acola.org.au.

249 ATP Innovations (2014) Australian incubator recognised as best in world, atp-innovations.com.au/best_incubatorinworld.

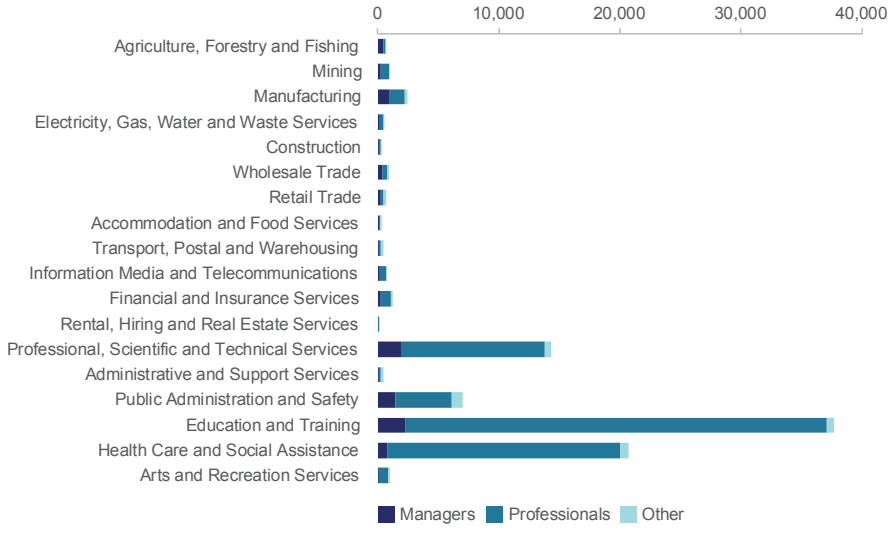
Figure 5.5 Engineers in the workforce, by sector, 2011



Notes: Total number of engineers = 106,453. Inadequately described, not stated, not applicable and overseas visitor categories are negligible and not included.

Source: 2011 Census of Population and Housing.

Figure 5.6 PhDs in the workforce, by sector, by occupation, 2011



Notes: Total number of PhD graduates = 94,671. Inadequately described, not stated, not applicable and overseas visitor categories are negligible and not included.

Source: 2011 Census of Population and Housing.

Table 5.1 Indicators of Australia's business collaboration activity by innovation-active businesses

Australian Trend Data (i)												OECD Comparisons				
Indicators	1995	2000	2005	2007	2008	2009	2010	2011	2012	2013	2014	Australia's score (ii)	OECD average (iii)	OECD top 5 average (iv)	Gap from the top 5 OECD performers (%) (v)	Ranking against OECD countries (vi)
Percentage of firms collaborating on innovation, % of innovation-active firms [1 2 (a)]	–	–	17.0	–	16.9	–	23.6	–	20.3	–	–	24.2	33.2	49.9	51	21
Percentage of SMEs collaborating on innovation [1 2 (a)]	–	–	17.0	–	16.8	–	23.6	–	20.1	–	–	24.0	31.7	47.7	49	29
Percentage of large firms collaborating on innovation [1 2 (a)]	–	–	22.4	–	23.2	–	24.4	–	32.3	–	–	33.1	55.5	75.4	56	29
Percentage of innovation-active businesses collaborating for any reason, % of respondents [3]	–	–	16.7	20.7	22.5	22.2	22.4	21.3	14.0	–	–	–	–	–	–	–
Percentage of non-innovation-active businesses collaborating for any reason, % of respondents [3]	–	–	6.0	6.5	7.6	6.7	7.4	6.8	4.6	–	–	–	–	–	–	–
Percentage of Australian businesses with international collaboration on innovation [2]	–	–	3.6	–	2.4	–	4.0	–	6.1	–	–	6.1	18.3	31.6	81	24
Percentage of innovation-active firms collaborating with universities or other research institutions excluding commercial [4]	–	–	12.1	–	9.5	–	9.6	–	–	–	–					
Percentage of innovation-active SME firms collaborating with universities or other research institutions excluding commercial [2 4 (a)]	–	–	12.1	–	9.5	–	9.6	–	–	–	–	4.1	13.9	27.6	85	29
Percentage of innovation-active large firms collaborating with universities or other research institutions excluding commercial [2 4 (a)]	–	–	12.7	–	15.8	–	13.7	–	–	–	–	3.5	35.2	61.0	94	30

– = data not available

Table notes: (i) Data are presented in calendar year format. Where the data are in financial years, it is expressed in terms of the year where the financial year begins e.g. 2010–11 is shown as 2010. (ii) The 'Australia's score' field presents the Australian values used in the OECD comparisons. (iii) This is the arithmetic (simple) average of the OECD country scores. (iv) This is the arithmetic (simple) average of the top five OECD countries in a ranked list. (v) This represents Australia's distance from the frontier as defined by the average of the top five ranked OECD countries. It is calculated as 100*(Top five average - Australia's score)/ Top 5 average. Where the solution is a negative value or zero, 'no gap' is shown in the cell. (vi) OECD rankings are performed on those OECD countries for which data are available. Individual data availability may vary between indicators.

Indicator notes: (a) The Australian values used in the calculation of the 'gap from the top 5 OECD performers' and the rankings against OECD countries are derived using the OECD business size definitions to ensure comparability between the Australian and OECD data. The OECD business size definitions are different to those that the ABS uses. Consequently, the values in the 'Australia's score' field differ from those presented in the time series under the Australian trend data for the corresponding year. Data are for product and/or process innovation Indicator notes.

Sources: [1] ABS (various) *Innovation in Australian Business*, Table 3, cat. no. 8158.0. URL: http://www.abs.gov.au/ausstats/abs@.nsf/mf/8158.0 [2] OECD (2013) OECD *Science, Technology and Industry Scoreboard* 2013 [3] ABS (various) *Selected Characteristics of Australian Business*, Table 3, cat. no. 8167.0, URL: http://www.abs.gov.au/ausstats/abs@.nsf/mf/8167.1. [4] ABS (2014) *Innovation in Australian Business*, special data request.

6. Framework conditions for innovation

The right framework conditions are necessary to support innovation, investment and competition. A favourable macroeconomic and policy environment; a business culture of innovation and entrepreneurship; openness to trade and investment; access to finance; knowledge and skilled labour; and a high degree of global connectedness are all essential ingredients for business innovation to thrive.

Australia has recorded economic growth for 23 consecutive years and has withstood the worst effects of the global financial crisis. Australia's real gross domestic product (GDP) grew from $824 billion to $1.451 billion between 1995 and 2012 (Table 6.1). Australia ranks 6th in the Organisation for Economic Co-operation and Development (OECD) for GDP per capita,[250] the common measure of our material standard of living (Table 1.1).[251]

Australia has generally favourable framework conditions for entrepreneurship and competitiveness (Table 6.1). This is evidenced through the flexibility and ease of starting businesses, workforce skills, inward foreign investment flows, openness of trade, high research and educational achievement, corporate governance, legal and political institutions, and transparency and integrity of public service. For instance, as shown in

250 GDP per head, US$, current prices, current PPPs (2012) stats.oecd.org/Index.aspx?DatasetCode=SNA_TABLE1#.

251 Although the average GDP per capita is increasing, the distribution of income and wealth is not evenly distributed. The top 10% of the Australian population had an average income of $152,742 compared to the average income of $37,811 for the other 90% in 2010 and this gap has been widening since the 1980s.

Table 6.1, we perform particularly well by OECD standards on framework conditions, such as for entrepreneurship.

Delgado et al. (2012)[252] suggest three measurement variables for foundational competitiveness:

- social infrastructure and political institutions (e.g. basic health and education, the quality of political institutions, and the rule of law)
- monetary and fiscal policy (e.g. fiscal sustainability, and debt and inflation policies for managing short- and medium-term fluctuations of economic activity)
- the microeconomic environment (e.g. organisation of industrial activity, business sophistication and management practices).

Strong political, social and judicial institutions are complemented by an independent Reserve Bank that helps to safeguard the integrity of economic policy making, whereas the Productivity Commission provides an independent check and sounding board for evidence-based policy.

It is often in the intermediate or enabling factors of innovation—such as collaboration, industry to research linkages, availability of capital and management capabilities—where there is room for improvement. Lack of access to funds has been consistently ranked as one of top two barriers to innovation by the OECD. Australia ranks 16th in the OECD for the number of venture capital deals relative to GDP (Table 6.1).

There was no real infrastructure support at all. There were very few venture capitalists around. But you know, they were very old school. So there was really no money, no network markets for tech start-ups to be talked about.

—Ian Gardiner, Viocorp

According to Enright and Petty, improvements to Australia's economic diversity, sophistication of companies, trade-to-GDP ratio, clustering of firms and industries, tax and regulatory burden, labour rules, cost of capital and public support for innovation would all help to ensure even more favourable framework conditions for Australian innovation and competitiveness.[253] Unlocking these advantages will become even more important as the economic benefits of the mining investment boom start to recede.

Australia's International Business Survey report[254] found that production and distribution costs relative to international competitors (the high value of the Australian dollar, labour costs, the degree of regulatory burden and transport/freight costs) were an important or the most important factor negatively affecting Australia's international competitiveness. Access to finance and export controls on goods and services were also noted as second order barriers to export.

252 Delgado M et al. (2012) *The determinants of national competitiveness*, National Bureau of Economic Research, NBER Working Paper Series 18249, Cambridge.

253 Enright MJ & Petty R (2013) *Australia's competitiveness: from lucky country to competitive country,* CPA Australia, Wiley & Sons, Singapore.

254 Export Council of Australia (2014) *Australia's International Business Survey 2014,* www.export.org.au/eca/trade-insights/background.

6.1 Barriers to trade

It is difficult for innovation to thrive in the economy if there are too many restrictions to the free flow of goods and services. These barriers and restrictions may lie within Australia or be imposed by our trading partners.

Tariff policies have changed over the years to remove protection to domestic industries and, in doing so, have improved competition and thereby innovation.[255] But trade restricting policy can also come in the form of non-tariff measures, such as quotas and import licences, as well as technical barriers to trade and trade costs more generally.

Given the complexities of non-tariff measures, identifying, classifying and measuring them can be a challenge. There is an extensive list of measures that can be considered non-tariff measures. The United Nations Conference on Trade and Development (UNCTAD) provides the most complete categorisation of non-tariff measures into either technical measures, non-technical measures or export-related measures.[256] [257] Technical barriers to trade refer to technical regulations and standards that set out specific characteristics of a product, such as its size, shape, design, function and performance. They also can stipulate the way a product is labelled or packaged.[258] Many of these measures serve legitimate goals of public policy, such as protecting the environment, or public health and safety. However, these technical barriers to trade may also have an impact on market access and export performance, which could amount to restricting international trade. The World Trade Organization (WTO) Agreement on Technical Barriers to Trade contains specific rules aimed at preventing these measures from becoming unnecessary barriers.

Although non-tariff measures are hard to quantify, the Heritage Foundation attempts this in its trade freedom index that measures and estimates tariff and non-tariff barriers, respectively. Australia received a trade freedom score of 86.4, which is within 4 points of top-ranked Singapore with a score of 90. The world average was 74.8, indicating that both Australia's tariffs and non-tariff measures are reasonably unrestrictive.[259]

255 Soames L et al. (2011) *Competition, innovation and productivity in Australian businesses,* Productivity Commission and Australian Bureau of Statistics research paper, cat. no. 1351.0.55.035, Canberra, www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/0/896C28E59CC4B822CA2579050014C578/$File/1351055035_sep%202011.pdf.

256 UNCTAD (2012) *Classification of non-tariff measures,* United Nations Publication, p. 3, unctad.org/en/PublicationsLibrary/ditctab20122_en.pdf.

257 The technical measures include the two most prevalent non-tariff measures—namely, technical barriers to trade, and sanitary and phytosanitary standards. The non-technical measures category includes many additional measures such as quotas, licenses, bureaucratic procedures and other measures that are often designed to deliberately restrict imports.

258 UNCTAD (2012) *Classification of non-tariff measures,* United Nations Publication, p. 3, unctad.org/en/PublicationsLibrary/ditctab20122_en.pdf.

259 Heritage Foundation (2014) *Index of Economic Freedom: trade freedom,* The Heritage Foundation www.heritage.org/index/trade-freedom.

A review undertaken by the WTO supports these findings.[260] It acknowledges that Australia has maintained the openness of its trade regime, and its exemplary transparency in trade and related policy. Australia's low tariffs are an indicator of Australia's strong trade liberalisation progress.

Trade costs other than technical barriers to trade, such as transport costs, geographic isolation, cultural and linguistic barriers, and a higher concentration of primary resources over manufactured exports can also impede trade. A Reserve Bank of Australia paper recently estimated that, due to these factors, trade costs in Australia were some 17% above the world average in 2011.[261]

Well-developed and strong intellectual property (IP) regimes also promote trade as a channel of technology transfer, particularly for industries that are research and development (R&D) intensive.[262] Recent research undertaken by IP Australia found that improving IP protection and enforcement regimes in destination countries would increase Australia's exports of elaborately transformed manufactures to those same countries.[263] This finding is consistent with the notion that higher value-added sectors tend to be more R&D intensive and, hence, more reliant on IP rights, both domestically and abroad.

Figure 6.1 shows Australia's low 'simple average applied most-favoured nation (MFN) tariff' compared to the eight lowest-scoring economies as well as the tariffs of Australia's major trading partners. Australia ranks 9th among 16 selected countries and the European Union (EU) for lowest average applied MFN tariffs across all products, with an average tariff of 2.7%. For the 'trade weighted average applied MFN tariff', Australia is at 2.5%,[264] showing lower values than the EU and key trading partners such as China and South Korea, but higher than the United States (US) and Japan.

260 World Trade Organization (in press) *Trade policy review—Australia.*

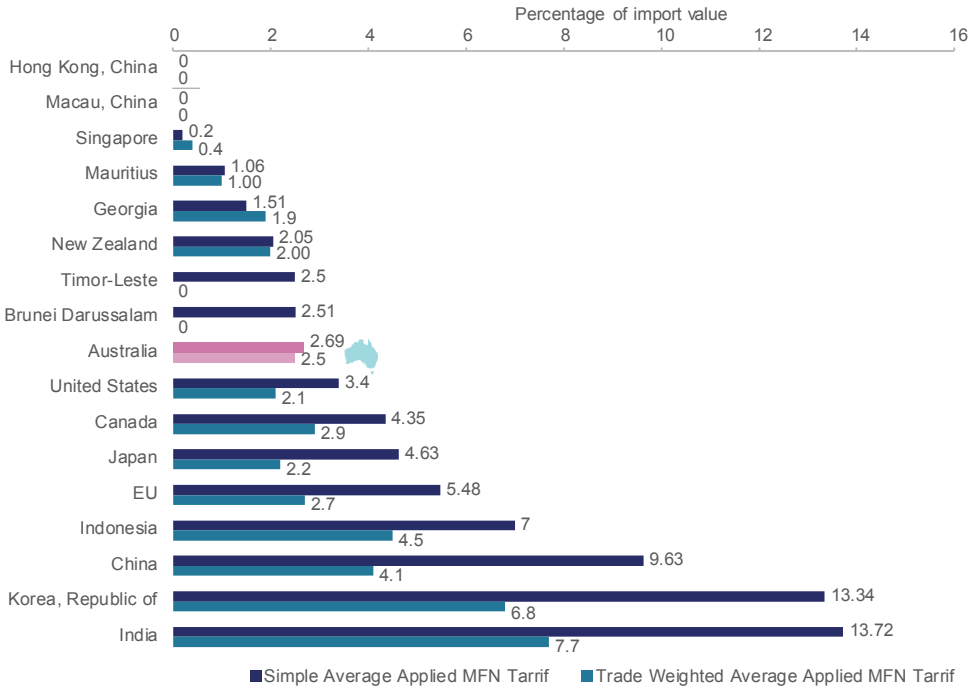
261 Kelly G & La Cava G (2014) *International trade costs, global supply chains and value-added trade in Australia,* RDP 2014-07, Reserve Bank of Australia, p. 27.

262 Falvey R et al. (2006) *Trade, imitative ability and intellectual property rights,* research paper 25, University of Nottingham.

263 McDaniel C (2014) *The relationship between international trade and patent rights: evidence for Australia's exports,* Office of the Chief Economist, IP Australia.

264 Many of our key trading partners, such as Korea and India, have high agricultural tariffs, which restrict trade in those goods and encourage trade in products with low tariffs, resulting in lowered trade weighted average tariffs.

Figure 6.1 Australia's tariffs compared to world's lowest and major trading partners, 2012



Note: Simple Average Applied MFN Tariff (2012 data, excluding Brunei and China 2011 data). Trade Weighted Average Applied MFN Tariff (2011 data, excluding Timor and Brunei data missing).

Source: International Trade and Tariff Data, 2011 and 2012, World Trade Organization, www.wto.org.

Australia ranks 134th in foreign market access because of the high tariffs faced by Australian exporters, especially for agricultural exports to some of our key Asian markets.[265] Australia will need a continued focus on winning access to foreign markets to increase exports to allow for greater gains from trade.[266]

Australia has prioritised conclusion of bilateral free-trade agreements (FTAs) with a number of Asian countries in the past decade. Agreements have already been signed during 2014 with Japan, South Korea and China, our three largest export markets, and negotiations are ongoing with India and Indonesia. Previously signed FTAs include those in force with New Zealand, Singapore, Thailand, the US, Chile, the Association of South-East Asian Nations (ASEAN) (with New Zealand) and Malaysia. These bilateral agreements, along with ongoing plurilateral negotiations, such as the Trans-Pacific Partnership and the Regional Comprehensive Economic Partnership will further reduce barriers to trade and investment.[267]

265 World Economic Forum (2014) *Global enabling trade report,* p. 19.

266 Lydon J et al. (2014) *Compete to prosper: improving Australia's global competitiveness,* McKinsey & Company, p. 45, www.bca.com.au/publications/building-australias-comparative-advantages.

267 Department of Foreign Affairs and Trade, www.dfat.gov.au/fta.

In addition to prioritised signing of FTAs, businesses engaged in exporting need to know how to use them. Recent research suggests that Australian exporters are among the least likely of major Asia–Pacific trading nations to use FTA provisions. On average, only 19% of Australian firms with exposure to cross-border trade and investment used FTA provisions compared to the regional average of 26%, although this rose to 30% in the case of the FTA with New Zealand.[268]

This increasingly liberalised environment for international trade in our region, coupled with greater awareness of the benefits of trade deals among internationally orientated firms, should create the incentive to innovate as more markets are opened up.

6.2 Australian online trade

There is a strong two-way link between information and communications technology (ICT) and innovation. As noted in Chapter 2, innovation-active businesses are about three times more likely to increase investment in ICT. This in turn might be expected to enhance their capability to market and otherwise better exploit their superior products. Total internet income for innovation-active businesses in Australia was $199 billion in 2010–11 compared to $39 billion for non-innovation-active businesses (see Chapter 2).

There seems little doubt that faster internet availability, as a digital innovation enabler, is an important framework condition for improved productivity. The uptake of ICT technologies by Australian businesses in the mid- to late-1990s was one factor in the high rates of productivity growth that we enjoyed at that time.[269] Broadband technologies enable a whole host of changed business conditions and business models for Australian small and medium-sized enterprises (SMEs) by facilitating their entry into overseas markets for final and intermediate goods and services, and providing broader access to skills and know-how.

Broadband technology is a significant factor in the phenomenon of firms that are 'born global'.[270] These firms have innovative products, but it is the availability of cheaper communications platforms that enables them to access the US and other overseas markets relatively quickly. Cochlear is cited as one such example of a born global Australian company.[271]

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268 Economist Intelligence Unit (2014) FTAs: fantastic, fine or futile? Business views on trade agreements in Asia, *The Economist,* London.

269 Modelling by Price Waterhouse Coopers suggests that a re-orientation of Australia towards innovation and digital technologies could increase Australia's productivity and raise GDP by $37 billion in 2024, PricewaterhouseCoopers (2014) *Expanding Australia's economy: how digital can drive the change,* www.pwc.com.au/digitalpulse; and Gretton P et al. (2004) *The effects of ICTs and complementary innovations on Australian productivity growth, in: The economic impact of ICT: measurement, evidence and implications,* OECD, pp. 105–24.

270 Cavusgil S & Knight G (2009) *Born global firms,* Business Expert Press, New York, pp. 23–6.

271 Ibid. p. 14.

Australian businesses are the most active in use of e-commerce out of all measured OECD countries, with some 37.8% reporting internet sales (Figure A.25). Interestingly, this use of selling online was virtually uniform in Australia across businesses of all sizes; in all other advanced economies, selling online was significantly more common for larger firms. Paradoxically, Australia is a laggard with respect to the volume of e-commerce, with only 7.7% of turnover generated from online sales (Figure A.26). This is well behind the leader Czech Republic, which reported 24.3% of all businesses' turnover from e-commerce.

We've always been an early adopter. Sometimes as the early adopter you'll get a lot of things wrong. But the challenge is to survive long enough. To not get things so spectacularly wrong that it kills you. That's one great thing about the internet. It allows you to take a lot of small risks as it's not that expensive anymore to go out and try something.

—Ian Gardiner, Viocorp

6.3 Foreign investment

A key measure of any country's competitiveness is its ability to attract foreign investment, especially foreign direct investment (FDI). FDI brings new products, services, know-how and ways of doing business, and is therefore often a driver of innovation and productivity growth.[272] In economic terms, it involves using the savings accumulated in other countries to stimulate development of the domestic economy, including skills, technology and market access. Greater levels of investment from overseas may also stimulate further gains in competitiveness and, therefore, productivity and growth.

Competition for FDI flows is intense, and Australia needs to provide the right conditions to attract and retain FDI. Coface, a global assessor of the average credit risk of companies in a country, uses macroeconomic, financial and political data for its risk assessment of various countries. In its most recent annual publication, Coface categorised Australia, along with the US, New Zealand, Germany, Austria, Denmark, Finland, Singapore and Malaysia, as 'low-risk' countries in terms of corporate default probability, whereas Canada, Switzerland, Norway, Sweden, Japan and Taiwan have been assessed as 'very low-risk countries'.[273]

Australia has performed well in recent years in attracting foreign investment. Based on UNCTAD data, Australia ranked 13th in the world in terms of its stock of FDI in 2012. Reflecting the strength of the mining boom and other factors, Australia's stock of FDI[274] rose from US$150 billion in 2002 to US$611 billion in 2012—a four-fold increase. Just as significantly, and reflecting the ongoing global attractiveness of Australia as a destination country for investment, FDI as a proportion of GDP rose from 34.5% in 2002 to 39% in 2012. This is significantly above the world average of 32.2%. As shown in Figure 6.2, Australia's share of global FDI was close to 2.0% in 2002—similar to the average share for individual developed economies. But

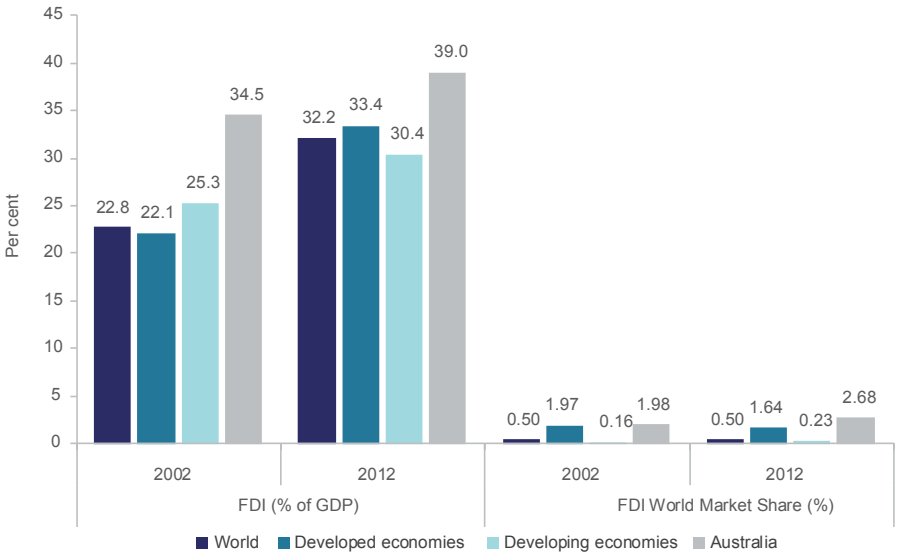
272 Fillat C & Woerz J (2011) Good or bad? The influence of FDI on productivity growth: an industry-level analysis, *The Journal of International Trade & Economic Development: An International and Comparative Review* 20(3):293–328.

273 Baque G et al. (2014) *Coface handbook of country risk,* Coface Group Economic Research Department, France.

274 The stock of FDI is the cumulative outcome of every preceding year's net inflows along with adjustments for changes in valuations, Austrade (2014) Buying into Australia's economic story: inward FDI: Austrade Economics Trade and Investment note 01.14, Sydney.

it subsequently rose to 2.7% in 2012, whereas the average for individual developed economies fell to just 1.6%.

Figure 6.2 Foreign direct investment (FDI) as percentage of GDP and FDI as a percentage of world total investment (average of individual economies), 2002 and 2012



Source: United Nations Conference on Trade and Development (2013) Inward and outward foreign direct investment stock, annual, 1980–2012.

Overall global investment competitiveness encompasses the cost of factor inputs (i.e. land, labour and capital) relative to a country's competitiveness as defined above. Costs in Australia are often high.[275] However, labour productivity varies considerably by sector.

Levels of FDI by industry sector correlate well with exports, innovation and productivity, especially in respect of the investment- and innovation-intensive industries of manufacturing and mining (Table 6.2). Together, mining and manufacturing accounted for around half the stock of FDI in Australia in 2012, almost half of Australian businesses' R&D expenditure in 2011–12 and well over half the value of Australian exports—despite only accounting for less than 20% of gross value-added in the Australian economy.

A country with high labour costs may be less competitive in making labour-intensive goods, but may not necessarily be less competitive overall. Rising relative labour costs have not had a negative impact on foreign investment into Australia. Many foreign investors continue to view Australia as a favourable place to invest (see also Chapter 1). For instance, Australia was the 9th largest recipient of FDI inflows in the world in 2013, with a total inflow

275 Total hourly compensation in manufacturing in Australia, for instance, is double that of Korea and around one-third more than in the United States on a US$ basis: Lydon J et al. (2014) *Compete to prosper: improving Australia's global competitiveness,* McKinsey & Company, p. 25.

of US$50 billion.[276] Australia was also the second largest destination overall for accumulated direct investment from China from 2005 to 2013—most of it in mining and energy.[277] Investment from traditional source countries, such as the US, the United Kingdom and Japan, also grew significantly during this period.[278]

6.3.1 Foreign ownership and innovation

Foreign ownership in itself may not directly drive international competitiveness. But an economy like Australia, which is open for investment from both domestic and overseas sources, is more likely to ensure that opportunities can be exploited to maximise competitiveness. Openness for business, in this sense, can facilitate the flow into Australia of new ideas and business models. These can be sourced from the most advanced global centres of excellence in various fields.

Foreign ownership means that novel (and potentially improved) business practices and products can be brought into the Australian market. It therefore provides a relatively inexpensive means for Australia to acquire capabilities that were originally developed offshore. This could include new business models that achieve reduced costs, or innovative new niche products or services. Once diffused into the Australian market, such innovation may be adapted or replicated more broadly by Australian industry. There may, in effect, be knowledge spill overs from foreign-owned firms. An economy that is therefore open to foreign ownership may become more competitive than an economy that restricts foreign acquisitions or places too many regulatory burdens in the way of investment.

A recent European study by Dachs and Peters (2013) confirmed greater innovation and productivity for foreign-owned firms. It also found that although greater process innovation and productivity growth in foreign-owned firms created employment losses, these were compensated by increased market share and sales from product innovation. This, in turn, generated net employment growth.[279] The study also concluded that foreign-owned firms could be more active drivers of modernisation and structural change in domestic economies.

Australian Bureau of Statistics (ABS) data indicate that foreign ownership contributes substantially to innovation. In 2011–12, businesses with more than 50% foreign ownership spent $5.6 billion on R&D in Australia—representing as much as 31% of total R&D expenditure by businesses in that

276 Austrade (2014) *Australia a top-10 foreign investment target, UNCTAD report shows*, Data Alert, 2 July, www.austrade.gov.au/invest/investor-updates/2014/australia-is-a-top10-foreign-investment-target-unctad-report-shows.

277 KPMG & University of Sydney (2014) *Demystifying Chinese investment in Australia,* March 2014 update, www.kpmg.com/AU/en/IssuesAndInsights/ArticlesPublications/china-insights/Documents/demystifying-chinese-investment-in-australia-march-2014.pdf.

278 Austrade (2014) *Australia's inward FDI stock exceeds A$600 billion in 2013,* Data Alert, 6 May 2014, www.austrade.gov.au/invest/investor-updates/2014/data-alert-australia-s-inward-fdi-stock-exceeds-a-600-billion-in-2013.

279 Dachs B & Peters B (2013) Innovation, employment growth, and foreign ownership of firms: a European perspective, *ZEW Discussion Paper 13-019*.

period.[280] The OECD similarly found that foreign affiliates typically account for a disproportionately high share of the home country's employment and value-add.[281]

With regard to management practices, the Management Matters report found that foreign-owned multinational manufacturing corporations with subsidiaries in Australia, as well as Australian-owned firms with operations overseas, performed significantly better on management capability than their purely domestic counterparts. According to the report, foreign-owned firms not only have better management capacity, but may also act to diffuse best practices to local firms through deployment of employees and knowledge and through commercial transactions with domestic firms.[282] The 2014 McKinsey report Compete to Prosper also reported that firms with international exposure more generally have more than double the rate of productivity growth, better management quality, and greater and more novel innovation.[283]

In addition to their role in introducing new technology and capabilities, foreign ownership may allow their Australian operations to open new networks for collaboration. It may, for instance, facilitate intrafirm trade across national borders and access to global supply chains. Multinational corporations are particularly skilled at establishing and linking into these global value chains and international production networks. The presence of multinationals in Australia may therefore offer opportunities for Australian SMEs to supply and access these larger overseas markets.

ABS analysis has found that exporting SMEs are more likely to have some degree of foreign ownership as compared to non-exporting SMEs. The difference between exporters and non-exporters was, in fact, quite large, with 18% of exporting SMEs reporting some degree of foreign ownership as compared to just 3% of non-exporters.[284] In 2010–11, 33.1% of businesses with more than 50% foreign ownership derived some income from exporting compared to just 7.9% of businesses with less than 50% foreign ownership (Figure 6.3). In the case of the manufacturing and information, media and telecommunications sector, this was particularly high, with more than 80% of majority foreign-owned businesses deriving income from exports.[285] Foreign ownership is associated with a stronger likelihood of higher degrees

280 ABS (2013) *Research and experimental development, businesses, Australia 2011–12,* Table 1.6 Business resources devoted to R&D, by level of foreign ownership—summary statistics, cat. no. 8104.0, ABS, Canberra.

281 OECD (2013) *OECD science, technology and industry scoreboard 2013,* OECD Publishing, p. 248.

282 Green R (2009) *Management matters in Australia: just how productive are we?* Department of Innovation, Industry, Science & Research, pp. 33–4.

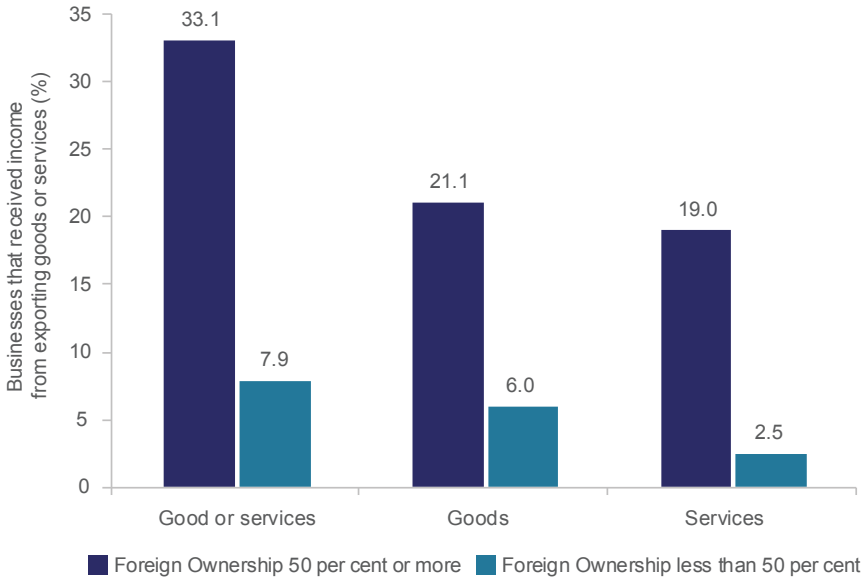
283 Lydon J et al. (2014) *Compete to prosper: improving Australia's global competitiveness,* McKinsey & Company, p. 9.

284 Hansell D &Talgaswatta TH (2009) *Exporting among Australian small to medium sized enterprises: an exploratory analysis of the business longitudinal database,* paper presented at the Australian Economists Conference, University of Adelaide, Adelaide, p. 12.

285 ABS (2014) *Business characteristics survey,* customised tables, Table 4 Businesses that received income from exports, by foreign ownership level, by industry, Canberra.

of novelty of innovation than is pure domestic ownership—businesses with more than 10% foreign ownership are about 60% more likely to achieve new-to-world innovation than businesses that are 100% domestically owned.[286]

Figure 6.3 Percentage of businesses that received income from exporting goods or services, by degree of foreign ownership, 2012–13



Source: ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

286 Department of Industry, Tourism and Resources (2006) *Collaboration and other factors influencing innovation novelty in Australian businesses: an econometric analysis,* Canberra, www.industry.gov.au/innovation/reportsandstudies/Pages/CollaborationandInnovationNovelty.aspx.

Table 6.1 Indicators of framework conditions in Australia

	Australian trend data										OECD comparison				
Indicators	1995	2000	2005	2007	2008	2009	2010	2011	2012	2013	Australia's score (ii)	OECD average (iii)	OECD top 5 average (iv)	Gap from the top 5 OECD performers (%) (v)	Ranking against OECD countries (vi)
Real Gross Domestic Product (GDP), billion A$ [1] [(a)]	876	1057	1252	1348	1371	1398	1430	1484	1521	1560	–	–	–	–	–
Real GDP Growth from previous year, % [2] [(a)]	3.9	1.9	3.0	3.7	1.7	2.0	2.3	3.7	2.5	2.5	–	–	–	–	–
Operating surplus, % of GDP [3] [(b)]	22.7	22.6	24.1	23.9	26.1	24.9	25.4	25.3	23.9	24.3	–	–	–	–	–
Index of Industrial Production [4] [(c)]	71.2	81.2	85.7	92.4	92.1	95.5	96.6	100.0	105.1	108.9	–	–	–	–	–
Index of capacity utilisation, % [5] [(d)]	79.7	80.4	82.5	83.3	82.4	80.2	82.1	81.0	79.9	79.7	–	–	–	–	–
Industry Value Added (chain volume measures), billion A$ [6] [(k)]	815	987	1169	1261	1286	1313	1342	1393	1431	1471	–	–	–	–	–
Unemployment rate (ABS), % [7] [(e)]	8.3	6.9	4.8	4.2	5.9	5.2	4.9	5.2	5.7	6.1	–	–	–	–	–
Inflation Rate (CPI), % [8]	3.1	6.1	4.0	4.4	1.4	3.1	3.5	1.2	2.4	3.0	–	–	–	–	–
Trade Weighted Index (TWI) [9] [(i)]	53.9	51.6	62.7	68.7	55.6	69.7	75.8	75.8	77.1	68.9	–	–	–	–	–
Business Confidence Survey, score [10] [(e)] [(g)]	7.7	–2.9	7.0	5.1	–20.8	8.5	–2.9	2.1	2.2	7.3	–	–	–	–	–
Barriers to innovation—any barrier, % of respondents [12]	–	–	38.1	43.7	43.2	44.6	44.9	45.1	44.1	–	–	–	–	–	–
Lack of access to additional funds, % of respondents [12] [(h)]	–	–	15.9	16	19.5	18.4	21.1	19.9	20.3	–	–	–	–	–	–
Government regulations or compliance, % of respondents [12] [(h)]	–	–	10.3	10.6	11.9	14.5	13	13.9	12.7	–	–	–	–	–	–
Proportion of businesses seeking debt or equity finance for innovation, % of respondents [13]	–	–	12.7	15.4	12.7	11.1	8.2	12.6	14.4	–	–	–	–	–	–
Financing through local equity market, 1–7 (best), score [14] [(h)]	–	–	6.31	5.89	5.34	4.60	4.59	4.66	4.72	4.97	4.97	3.86	4.92	No gap	2
Ease of access to loans, 1–7 (best), score [14] [(h)]	–	–	4.83	4.88	4.94	4.40	3.92	3.68	3.68	3.51	3.51	3.01	4.21	17	10
Venture capital availability, 1–7 (best), score [14] [(h)]	–	–	4.83	4.66	4.43	3.97	3.83	3.54	3.34	3.56	3.56	3.02	4.24	16	8
Venture Capital Investment, million A$ [15]	–	–	605	901	683	420	259	332	265	–	–	–	–	–	–
Later Stage Private Equity investment, million A$ [15]	–	–	1177	1868	994	824	955	843	856	–	–	–	–	–	–
Venture capital investments, % of GDP [15] [16] [17]	–	–	0.061	0.077	0.054	0.032	0.018	0.022	0.017	–	0.02	0.04	0.15	86	18
Market capitalization of listed companies, % of GDP [18]	66.6	89.8	115.9	152.1	64.0	135.8	127.4	86.4	83.9	–	83.9	61.7	130.8	36	10
Stocks traded, total value (current US$ billion) [19]	99	226	616	1323	1018	762	1222	1246	1052	–	1052	1122	6042	83	9
Stocks traded, total value, % of GDP [19]	26.8	54.5	88.8	154.9	96.4	82.2	107	89.9	68.6	–	68.6	38.1	107.9	36	7
Stocks traded, turnover ratio, % [19]	42.5	56.5	78	110.5	103.1	78.8	90.1	94	84.7	–	84.7	59.8	134.7	37	8
Gov't procurement of advanced tech products, 1–7 (best), score [20] [(h)]	–	–	4	4.2	4.1	4	4.1	3.9	3.7	3.6	3.6	3.7	4.4	17	21
Firm-level technology absorption, 1–7 (best), score [14] [(h)]	–	–	5.5	5.7	5.8	5.9	5.9	5.8	5.9	5.8	5.8	5.5	6.1	5	10
Entrepreneurial intentions, % [20] [(i)]	–	7.8	12	–	–	–	8.7	12.3	–	–	12.3	12.9	26	53	9
Buyer sophistication, 1–7 (best), score [14] [(h)]	–	–	5.8	5.3	4.8	4.7	4.4	4.2	4.1	3.8	3.8	3.9	4.9	23	21
Percentage of final household consumption expenditure on Health, Communications and Education, % [21]	9.6	10.6	11.8	11.7	12.1	12.2	12.3	12.5	12.9	–	12.9	8.9	16.4	21.1	4

	Australian trend data										OECD comparison				
Indicators	1995	2000	2005	2007	2008	2009	2010	2011	2012	2013	Australia's score (ii)	OECD average (iii)	OECD top 5 average (iv)	Gap from the top 5 OECD performers (%) (v)	Ranking against OECD countries (vi)
Statutory corporate income tax rates, % [22 (h)]	–	–	30	30	30	30	30	30	30	–	30	25	35	15	6
Start-up procedures to register a business, count [18]	–	–	3	3	3	3	3	3	3	3	3	5	–	–	–
Cost of business start-up procedures, % of GNI per capita [18]	–	–	1.9	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	4.5	0.2	218	8
ISO 14001 environmental certificates, per billion PPP$ GDP [23]	–	–	–	–	–	–	–	–	–	15.6	15.6	36.1	91.1	83	23
Total environment related taxes, % of GDP [24]	2.57	2.41	2.20	1.94	1.81	1.83	1.77	1.77	2.00	–	2.0	2.3	3.7	46	24

– = *data not available*

Table notes: (i) Data are presented in calendar year format. Where the data are in financial years, it is expressed in terms of the year where the financial year begins e.g. 2010–11 is shown as 2010. (ii) The 'Australia's score' field presents the Australian values used in the OECD comparisons. (iii) This is the arithmetic (simple) average of the OECD country scores. (iv) This is the arithmetic (simple) average of the top five OECD countries in a ranked list. (v) This represents Australia's distance from the frontier as defined by the average of the top five ranked OECD countries. It is calculated as 100*(Top five average - Australia's score)/ Top 5 average. Where the solution is a negative value or zero, 'no gap' is shown in the cell. (vi) OECD rankings are performed on those OECD countries for which data are available. Individual data availability may vary between indicators.

Indicator notes: (a) Chain volume measures in original terms and annual time series from June to June. (b) Gross operating surplus (GOS), current prices in original terms; GDP, current price in original terms. Index is calculated as (GOS/GDP x 100%). (c) Index numbers in original terms, and annual time series available from June 1975 to June 2014. (d) Annual calendar year average of monthly and seasonally adjusted time series. 1997 data are used for 1995. (e) Monthly and seasonally adjusted time series. (f) Monthly time series and not seasonally adjusted. (g) 1997 data are used for 1995. (h) 2006 data are used in the absence of 2005 data. (i) 2002 data are used in the absence of 2000 data. j) May 1970 = 100; values are for December month. (k) Series ID A2304757K; series type original; data type derived; collection month is June.

Sources: [1] ABS (2014) Australian System of National Accounts, 2013-14, Table 2. Expenditure on Gross Domestic Product (GDP) cat. no. 5204.0. [2] ABS (2014) Australian System of National Accounts, 2013-14, Table 1. Key National Accounts Aggregates, cat. no. 5204.0. [3] ABS (2014), Australian System of National Accounts, 2013-14, Table 17. Non-Financial Corporations Income Account, and Table 1, Key National Accounts Aggregates cat. no. 5204.0. [4] ABS (2014) Australian National Accounts: National Income, Expenditure and Product, June 2014, Table 39, Indexes of Industrial Production, cat. no. 5206.0. [5] Thomson Reuters DataStream (2014) Industry Production and Utilisation. [6] ABS (2013) Australian National Accounts: National Income, Expenditure and Product, Mar 2013, Table 33, Industry Gross Value Added, cat. no. 5206.0. [7] ABS (2013) Labour Force, Australia, May 2013, Table 2, Labour force status by Sex, cat. no. 6202.0. [8] ABS (2014) Consumer Price Index, Australia, Sep 2014, cat. no. 6401.0. [9] RBA (2013) Trade Weighted Index (T WI). [10] Thomson Reuters DataStream (2014), National Australia Bank (NAB) Business Survey. [11] ABS (2008 - 2013) Selected Characteristics of Australian Business, 'Barriers to innovation - by innovation status, employment size, and industry', data cube: Excel spreadsheet, cat. no. 8167.0. 2011–12, Table 1. URL: http://www.abs.gov.au/ausstats/abs@.nsf/mf/8167. [12] 0OECD (2013) Entrepreneurship at a Glance. Accessed: 22 May 2014, doi: 10.1787/data-00283-en; ABS (2008-2013) Selected Characteristics of Australian Business, 2011–12, 'Table 2 Reasons for seeking debt or equity finance, by innovation status, by employment size, by industry, 2011–12', data cube: Excel spreadsheet, cat. no. 8167.0. www.abs.gov.au/ausstats/abs@.nsf/mf/8167.2; [13] ABS (2008 - 2013) Selected Characteristics of Australian Business, 2011–12, Table 2 data cube, cat. no. 8167.0. Selected Characteristics of Australian Business, 2011–12, Table 2 URL: http://www.abs.gov.au/ausstats/abs@.nsf/mf/8167.2. [14] World Economic Forum (2013) *Global Competitiveness Index* 2013-14. URL: http://www.weforum.org/issues/global-competitiveness.[15] ABS (various) *Venture Capital and Later Stage Private Equity*, Australia, cat. no. 5678.0 and Department of Industry calculations. [16] ABS (2012) Australian National Accounts: National Income, Expenditure and Product, Mar. 2013, cat. no. 5206.0. [17] OECD, *Entrepreneurship at a Glance* 2013 for the OECD comparison data. [18&19] World Bank (2014) World Development Indicators 2014. URL: http://data.worldbank.org/data-catalog/world-development-indicators [20] Global Entrepreneurship Research Association (2014) *Global Entrepreneurship Monitor* URL: http://www.gemconsortium.org/ [21] OECD Stat. database. [22] KPMG (2014) Corporate tax rates by country. 2013. URL: http://www.kpmg.com/global/en/services/tax/tax-tools-and-resources/pages/corporate-tax-rates-table.aspx. [23] Cornell University, INSEAD, WIPO (2013) *Global Innovation Index* GII2013. URL: http://www.globalinnovationindex.org [24] OECD (2014) *Green growth indicators 2014*.

Table 6.2 Industry shares of FDI stock, exports, BERD, gross value-added and employment, 2012

Industry	FDI,[1] %	Exports, %	BERD, % (2011–12)	Gross Value-Added, %	Employment (2012) (%)
Mining	34.6	53.9	22.4	10.6	2.3
Manufacturing	15.3	13.4	24.4	7.7	8.4
Other	50.1	32.7	53.2	81.7	89.3

Sources: (1) ABS 2014, International Investment Position, Australia, Supplementary Statistics (Catalogue No.5352.0), Table 15A: Foreign Investment in Australia, Level of Investment as at 31 December 2012, by industry division (ANZSIC), Direct Investment in Australia; (2) ABS 2013, Research and Experimental Development, Businesses, Australia 2011–12 (Catalogue No. 8104.0), Table 1.7: Business Expenditure on R&D, by ANZSIC06 industry subdivision, by source of funds, 2011–12; (3) Department of Foreign Affairs and Trade 2013, Trade at a Glance 2013, pp.2, 20.

Note: 'Other' combines totals for all 17 other Australian industries besides manufacturing and mining based on the Australian and New Zealand Standard Industrial Classification.

7. Innovation and skills

Skilled people drive innovation and competitiveness by generating new knowledge and adapting new and old ideas to a changing world.[287] In fact, the long-term relationship between skills, innovation and employment may be characterised as a 'virtuous cycle'.[288] A recent Organisation for Economic Co-operation and Development (OECD) review of the literature on skills and innovation found that differences in the quantity and quality of skills across OECD member countries is a major factor influencing their levels of observed innovation and overall economic performance, mediated by organisational factors in the workplace.[289] In a globalised economy, trade-exposed industries are competing with world's best practice. Exporters therefore need access to business and technical skills sufficient to compete.

Just like higher education, the vocational education and training (VET) sector is an important adjunct to the national innovation system. Skills that are attuned to vocational situations and the actual needs of the workforce are required to ensure that new and improved products and processes have technical and commercial applicability. Workers often need a combination of knowledge acquired from higher education and vocational education to realise workforce gains. According to Toner and Dalitz, the nature of innovation in Australia often makes VET skills more important than in other OECD countries,[290] the vocational and technical skills required in the mining industry being one such example.

7.1 Australia's skills base

Our workforce is becoming more educated (Table 7.1). As innovation occurs in all sectors throughout the economy, and in all stages of production and distribution, the skills needed are wide ranging. These include technical skills such as those required for the trades, and in design and engineering that are necessary for creating new technologies and products, as well as management skills needed to adopt and adapt innovations. According to the Australian Academy of Learned Sciences (ACOLA), this combination of technical and non-technical skills, along with superior management capabilities, will be keys for Australia to unlock future innovation and productivity growth.[291]

287 OECD (2011) *Skills for innovation and research,* OECD Publishing; and Bell J et al. (2014) *The role of science, research and technology in lifting Australian productivity,* report for the Australian Council of Learned Academies (ACOLA), ACOLA, Melbourne, pp. 93–119, www.acola.org.au.

288 Ibid., p. 30.

289 Ibid., p. 61.

290 Toner P & Dalitz R (2012) *Vocational education and training: the 'terra incognita' of Australian innovation policy,* www.aomevents.com/media/files/ISS%202012/ISS%20SESSION%208/Toner.pdf.

291 Bell J et al. (2014) T*he role of science, research and technology in lifting Australian productivity,* report for the Australian Council of Learned Academies (ACOLA), ACOLA, Melbourne, pp. 93–119, www.acola.org.au.

Trades (training) is a really expensive thing to run. There's nothing cheap about doing it properly. Part of our survival depends on the partnerships, and how well we can at a local level—in a changing funding environment—build that sustainability in. We keep those industry partnerships by doing what we say we're going to do.

—Mary Campbell, SkillsTech Australia

That practical reinforcement of the theory really makes the light bulb come on.

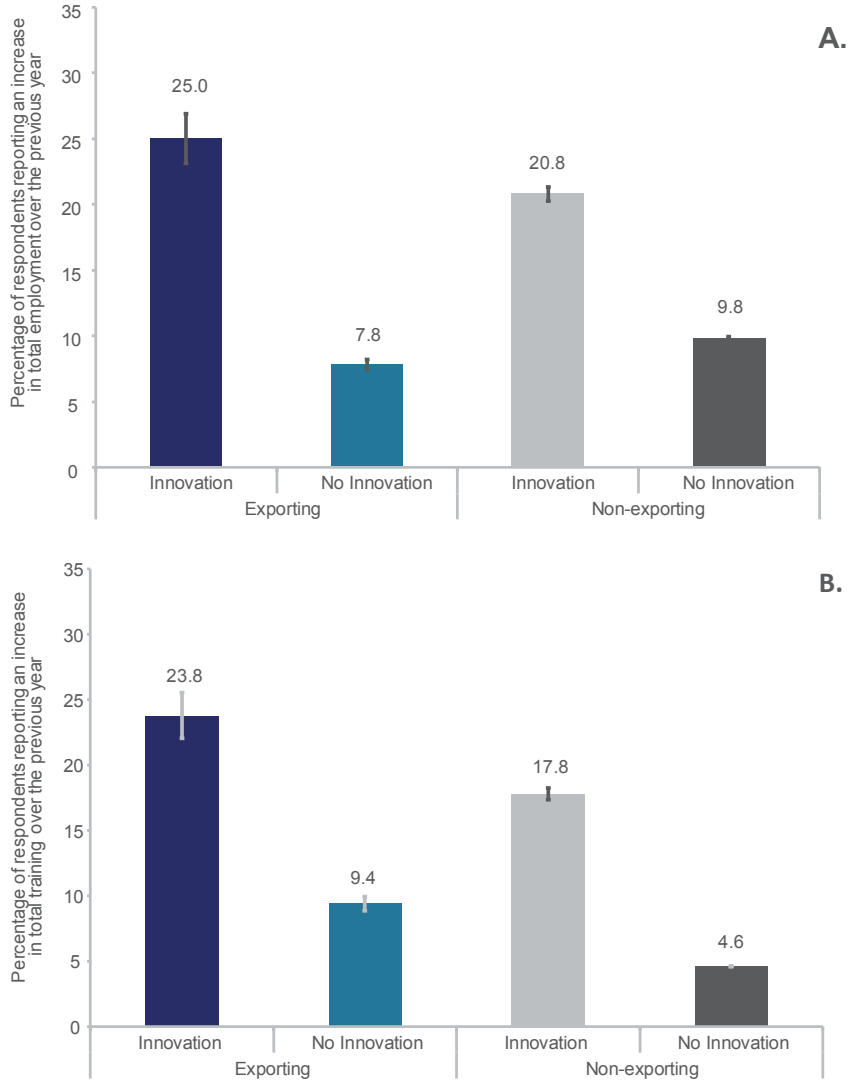
—Garry Hargreaves, SkillsTech Australia

The proportion of 25–34-years olds with a bachelor degree or above has risen dramatically from 14.3% in 1995 to 35.2% in 2013. Australia ranked 8th in the OECD by this measure, although still below the OECD top five of 40.2%. Under the Programme for International Assessment of Adult Competencies (PIAAC), achievement for the percentage of adults scoring at proficient levels for literacy and for problem solving in technology-rich environments were above the OECD average, but below the score for the OECD top five. For numeracy, Australia was slightly below the OECD average.

In 2012–13, innovation activity and exporting activity among Australian firms were both associated with a substantially increased likelihood to increase their employment compared to the previous year (Figure 7.1). Innovation had a greater impact on business employment growth than exporting activity alone (Figure 7.1A). Figure 7.1B also shows similar strong positive impacts on investment in training when firms are innovators and/or exporting. Exporting activity in itself also substantially increases the likelihood of skills enhancement through formal training, but not by as much as innovation.

Not surprisingly, a lack of skilled people has been one of the highest reported barriers to innovation in businesses in recent years. Innovation-active firms are generally more likely than non-innovation-active firms to indicate a lack of skills as a barrier to innovation (Figure A.27).

Figure 7.1 Likelihood of business employment (A) and training (B) growth, by export status, by innovation status, 2012–13



Source: ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

Box 7.1 Case study: SkillsTech Australia[292]

For publicly provided training to be effective and relevant, it needs to produce graduates with the latest skills that industry needs. Where industry needs constantly change, a high degree of collaboration between training providers and employers is vital.

TAFE Queensland SkillsTech exemplifies this approach. It is the only public provider specialist of trade technical training in Queensland. Formed as an amalgamation of six TAFE institutes across Brisbane in 2006, the Registered Training Organisation (RTO) has an intake of around 22,000 a year—of which some 10,000 are apprenticeships.

TAFE Queensland SkillsTech's specialty is in the so-called heavy trades—automotive, building and construction, electrical and electronics, manufacturing, engineering, mining, gas, water, and utility industries. The RTO has many long running partnerships with leading corporations in these industries like Toyota, Bechtel and Santos GLNG.

However, what also makes TAFE Queensland SkillsTech truly unique, according to General Manager Mary Campbell, is its degree of industry collaboration and tailored training solutions. 'We try to deliver [skills training] with industry participation in whatever we do'.

Mary expands on this approach. 'When a need within their organisation changes, they come to us and we talk about how we can help them define what a solution looks like and how to turn that into a new viable training resolution'.

This partnership approach with regulators, universities, industry skills councils and businesses of all sizes allows TAFE Queensland SkillsTech to constantly refine systemic training packages to take into account the latest innovation in industry and gives students hands-on experience in a safe environment.

According to Director of Educational Support Services Basil Harvey, another of TAFE Queensland SkillsTech's innovative approaches is to always watch out for new trends in the industries that they train for. This is particularly the case for industries like coal seam gas (CSG), where new technologies are emerging all the time.

Corporate Solution Manager of CSG Sector Garry Hargreaves explains, 'we've got such great relationships with all those partners, they tell us what's happening and which fields we're going to have to move into. Instead of being a year behind, we end up being a month behind, a week behind, or even forecasting what their needs are going to be'.

One of these trends was high-density polyethylene (HDPE) pipe welding. 'That was a need we saw that not one gas provider, not two gas providers, but all the gas providers were talking about. But there wasn't really a systemic approach to the training', says Garry.

292 Based on an interview conducted on 7 May 2014

TAFE Queensland SkillsTech therefore took the initiative of setting up a $260 million Centre of Excellence in this technology based on this need.

'Iplex and Georg Fischer were keen for their training to take-off in the marketplace, because if people don't get trained on how to weld the pipe properly, you can get errors,' Garry explains.

Industry partners are investing in their own future by not only co-funding the Centre of Excellence, but also donating a lot of expensive materials that are vital to training students, which results in students training on the equipment they will use daily in the field.

Another innovation that TAFE Queensland SkillsTech has pioneered is its use of e-learning. This isn't just e-learning for students. It's e-learning to connect up industry players. 'We were organising online forums and webinars to get companies together to talk to each other about the assessment and moderation of their industries,' explains Basil Harvey.

E-learning is particularly important, given the remote operations of much of Queensland's heavy industry, such as CSG and liquid natural gas mining.

'Everybody does online training and they have for a while. We've got to be a little bit more innovative and think about how do we do that outside of a wireless network … we're talking about the small percentage of Australia where you can't get reliable internet coverage', says Basil.

TAFE Queensland SkillsTech developed onsite remote training that could be delivered on a tablet device in places where there is no internet service. 'They record what they do onsite. Then when they come back into wireless connection they communicate it back with us … It's affectionately known as the "tradie selfie"', says Basil.

SkillsTech students and teacher

Skills at the coal face

This symbiotic relationship with industry and the ability to always keep pace with emerging trends is what drives TAFE Queensland SkillsTech and makes it easier for staff to do their job better. As Mary Campbell puts it, 'you never know where an industry partnership may lead you!'

7.2 Skill usage and shortages reported by innovative Australian exporters

Innovative businesses and exporters have significantly higher use of science, technology, engineering, mathematical (so-called STEM) skills than non-innovators (Figure 7.2). The strong relationship between STEM skills, innovation and competitiveness is well documented in the literature on these topics. According to a study by Palangkaraya et al., businesses that report using these skills are 33% more productive than those that do not.[293]

Innovative Australian businesses are also more likely than non-innovative businesses to report skills shortages (Figure 7.3). In skill categories most used, for example, like project management and marketing, innovators have been two to three times more likely to report shortages. Innovators in scientific, research and information technology (IT) skill categories have reported even higher relative shortages (i.e. four to seven times higher).[294]

Based on an analysis of the Business Characteristics Survey of Australian firms in 2011–12 (see Figure 7.2), there is a general cascading effect by business classification with innovation-active, exporting businesses showing the highest use of STEM and business professional skills. Businesses that were neither innovation-active nor engaged in export trade were least likely to report using these types of skills. Businesses that were either innovation-active or exporters fell between the two extremes. Interestingly, this cascading effect did not hold true for trades or transport, and plant and machinery workers, where there was no particular additional use of these types of skills for exporting and innovation-active firms. Where firms either innovate or export (but not both), there tends to be greater use of the higher-end skills of engineering, science and research, marketing, business management and project management among exporters than for innovators. This could also be partly explained by the fact that exporting firms are more likely to be larger and therefore more likely to employ persons with these given skills.

The opposite is true for IT and financial skills, where innovative non-exporters reported more use of these skills than non-innovation-active

293 Palangkaraya A et al. (2014) *Is science-based innovation more productive? A firm level study,* ACOLA consultant report, Melbourne.

294 See the A*ustralian Innovation System Report 2012,* Canberra p. 37.

exporters. Innovators are more likely to report actual shortages or deficiencies across the range of skills reported in the survey (Figure 7.3).[295]

Innovative exporters are more likely to report shortages or deficiencies in research, technology and engineering skills. Innovative exporters have a greater demand for IT skills. This is not surprising since, as noted in Chapter 6, innovation-active businesses are much more likely to report greater investment in IT, which has been a factor in the globalisation of businesses generally.

Mining and manufacturing industries report high intensity in their use of STEM skills. Innovation- and export-active firms in these two industries were the most likely to report use of engineering, and science and research skills, as well as the most likely to report skill shortages in engineering. Manufacturing was also the industry most likely to report shortages in science and research skills.[296]

Figure 7.4 aggregates university and VET completion data into similar skill categories used in Figures 7.2 and 7.3. The data show that growth in marketing, business management, financial, IT professional and IT support technician completions have been below national averages. Given the high demand for these skills by innovators and exporters, this may represent a significant future limitation to Australia's international competitiveness if skilled migration cannot make up the shortfall. Some IT skills are currently on the Skilled Occupation List.[297] For domestic innovators, a below-average growth rate in transport, plant and machinery operation may also be a limitation on more technological innovation (Figure 7.4).

Phil (di Bella) is the brains trust. He started on the front of house as a barista … he learnt everything he could about being a barista and then naturally evolved into the coffee industry more generally. He then realised there was an opportunity in the market for him to move away from the end of the process to the middle of the process and eventually the beginning of the process.

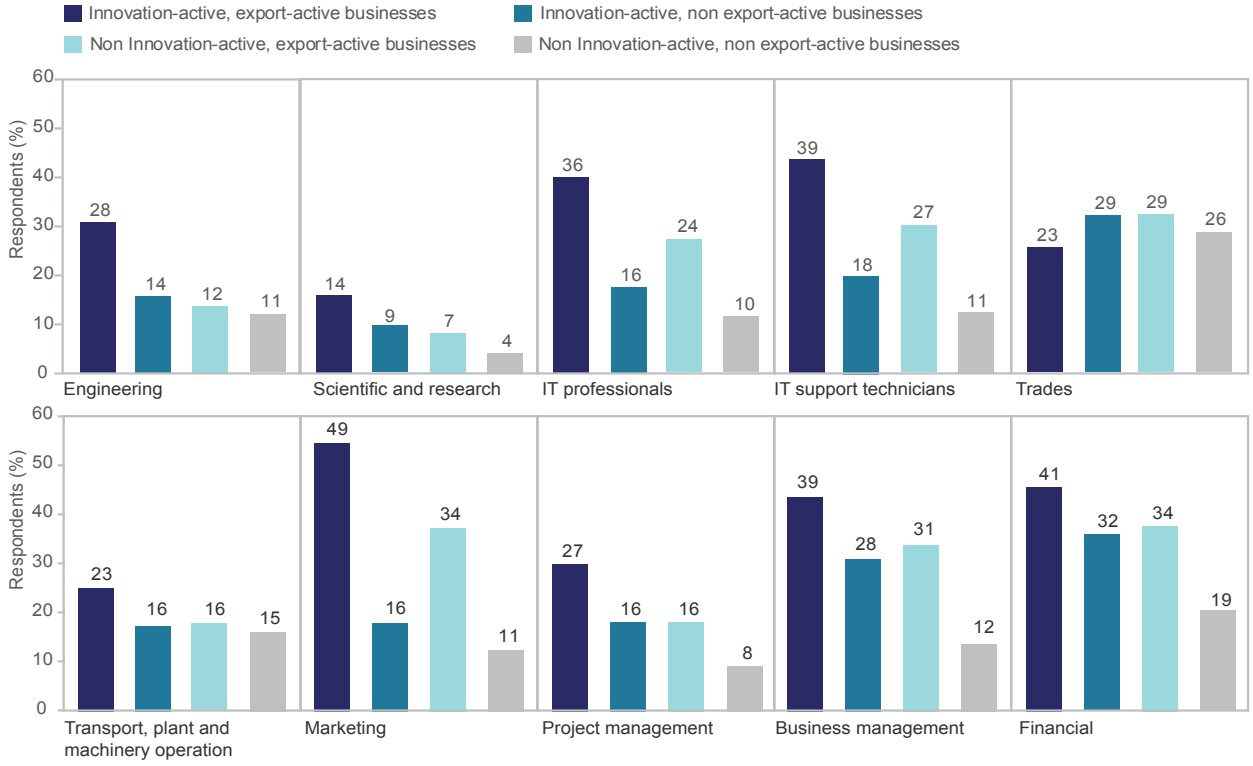
—Michael Drummond,
Di Bella Coffee

295 In terms of overall vacancies reported in the Department of Employment's Vacancy Report, technicians and trades workers (up by 18.9%), and community and personal service workers (16.9%) reported the largest increase in internet vacancies in the 12 months to July 2014. Department of Employment (2014) Vacancy report, Canberra, lmip.gov.au/default.aspx?LMIP/VacancyReport.

296 ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

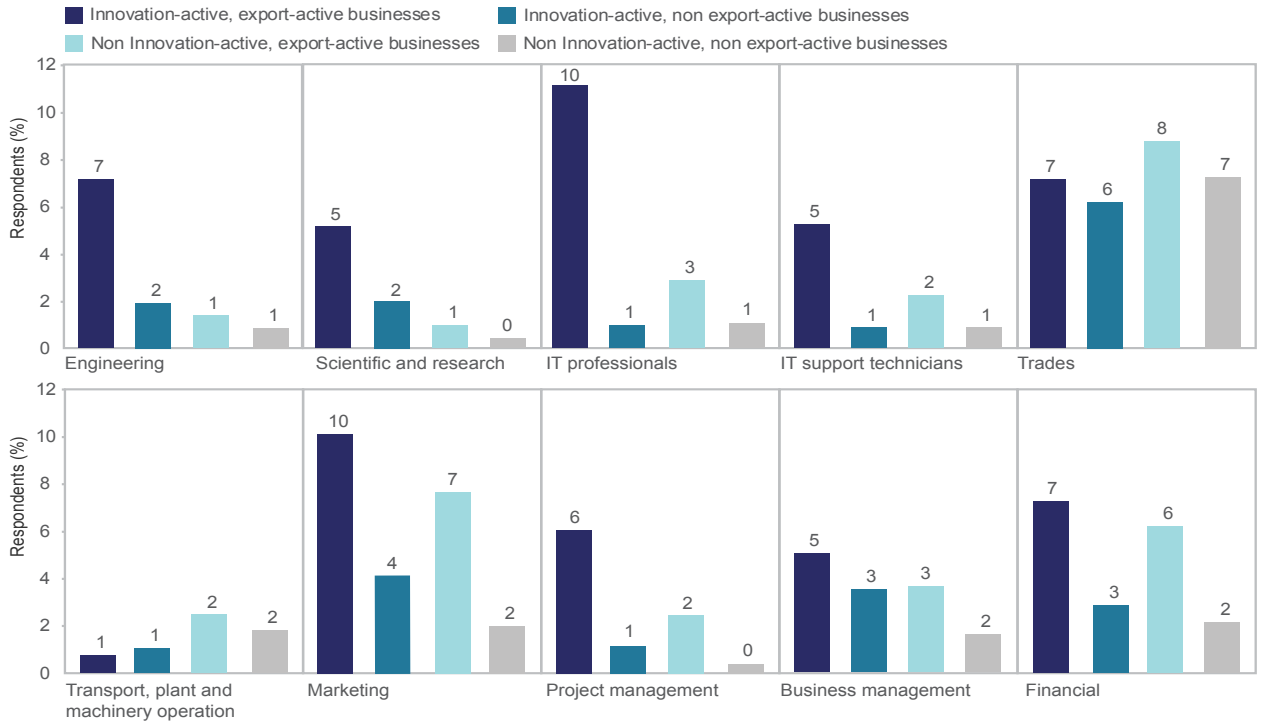
297 Department of Immigration and Border Protection (2014) *Skilled Occupation List (SOL)*, Canberra, www.immi.gov.au/Work/Pages/skilled-occupations-lists/sol.aspx.

Figure 7.2 Skills used, by innovation and export status, 2012–13



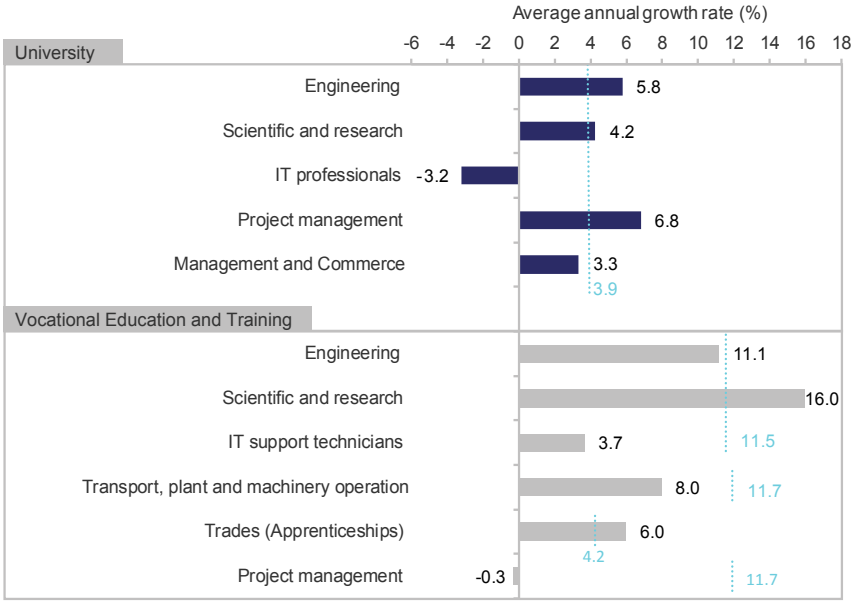
Source: ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

Figure 7.3 Skill shortage or deficiency reported, by innovation and export status, 2012–13



Source: ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

Figure 7.4 University and vocational education and training growth in completion rates, by skill category, compared with the sector benchmark (blue line), 2007–13



Notes: The blue line indicates the growth benchmark for the entire, relevant sector. Marketing, business management and financial skills have been grouped into 'management and commerce'.

Sources: NCVER VOCSTATS (students 2002–2013, Apprentices and trainees, March 2014), www.ncver.edu.au; university data: uCube, higher education statistics, Australian Government Department of Education, highereducationstatistics.education.gov.au.

7.3 Skilled migration, innovation and exports

According to Atkinson and Ezell, a crucial component of international competitiveness is the migration of highly skilled people.[298] Migration can be a cost-effective means for a country to acquire the skills that its economy needs. Since the end of the Second World War, Australia has been at the forefront of developing and implementing effective and innovative skilled-migration policies that are responsive to labour market demand.[299] Some authors have also suggested that immigration can even lead to an increase in trade with the migrants' country of origin[300] and greater productivity.[301]

298 Atkinson RD & Ezell SJ (2012) *Innovation economics: the race for global advantage,* Yale University Press, New Haven and London, p. 262.

299 Australia already has more than nine times the rate of skilled migration as the United States. Productivity Commission (2006) Economic impacts of migration and population growth, Australian Government, Canberra, p. 42; and Shachar A (2006) *The race for talent: highly skilled migrants and competitive immigration regimes,* New York University Law Review 81:148–206.

300 Franzoni C et al. (2012) The mover's advantage: scientific performance of mobile academics, NBER Working Paper 18577, Cambridge, MA; Moretti E (2012) *The new geography of jobs,* Houghton Mifflin Harcourt, New York; and OECD (2013) *OECD science, technology and industry scoreboard 2013,* OECD Publishing, pp. 61, 132.

301 Productivity Commission (2006) *Economic impacts of migration and population growth*, Australian Government, Canberra, p. 45; and Partridge JS (2008) *Essays on immigration, innovation and trade*, thesis for Degree of Doctor of Philosophy, Department of Bio-resource Policy, Business, and Economics, University of Saskatchewan, Saskatoon.

Modelling of future workforce needs shows that Australia faces a potential shortfall of 2.8 million in supply of skilled workers with at least diploma-level qualifications by 2025. Migration will therefore continue to be a key strategy for addressing these challenges tied to enhancing our capacity to innovate and compete.[302] Skilled migration intake has returned to levels seen before the global financial crisis (Table 3.1).

There is growing international evidence of the link between migration patterns on the one hand and innovation in the domestic economy on the other.[303] In Australia, this perception of migrants' capacity to augment innovation is reflected in the introduction in 2012 of the Business Innovation and Investment Programme (subclasses 188 and 888) as one of the core components of Australia's skilled migration program. This program includes points for 'business innovation' in which prospective migrants are tested against factors such as their registered patents, designs and trademarks, joint venture agreements, export trade, gazelle businesses, and receipt of grants or venture capital funding for an innovative business idea.[304]

302 AWPA (2013) *Future focus: National Workforce Development Strategy,* Australian Government, Canberra, www.awpa.gov.au.

303 For a review of the literature, see Smith R (2011) *Migration and the innovation agenda,* Department of Innovation, Industry, Science and Research Working Paper 2011–02, Canberra; Jensen PH (2014) Understanding the impact of migration on innovation, *The Australian Economic Review* 47(2):240–50; and Hunt J & Gauthier-Loiselle M (2010) How much does immigration boost innovation? *American Economic Journal: Macroeconomics* 2(2):31–56.

304 In respect of exports, for instance, points are awarded where one or more of the applicant's nominated main businesses have derived at least 50% of annual turnover from export trade for at least two of the preceding four fiscal years: Department of Immigration and Border Protection, www.immi.gov.au/Visas/Pages/188.aspx.

Table 7.1 Australia's education and skills base

	Australian trend data (i)											OECD comparison				
Indicators	1995	2000	2005	2007	2008	2009	2010	2011	2012	2013	2014	Australia's score (ii)	OECD average (iii)	OECD top 5 average (iv)	Gap from the top 5 OECD performers (%) (v)	Ranking against OECD countries (vi)
Total expenditure on educational institutions, % of GDP[1]	5.05	5.22	5.31	5.18	5.18	6.00	6.13	–	–	–	–	6.13	6.26	7.68	20	18
Public expenditure on education, % of GDP [1]	4.80	4.58	4.52	4.28	4.18	4.99	5.15	–	–	–	–	5.15	5.78	7.87	35	22
Expenditure on tertiary education institutions, % of GDP [1]	1.57	1.45	1.47	1.55	1.49	1.62	1.63	–	–	–	–	1.63	1.61	2.49	35	11
Public expenditure on tertiary education, % of GDP [2]	–	1.16	1.14	1.00	0.97	1.10	1.15	–	–	–	–	1.15	1.38	2.24	49	19
Expenditure on primary, secondary and postsecondary (nontertiary educational) institutions, % of GDP [1]	3.39	3.64	3.74	3.51	3.57	4.22	4.35	–	–	–	–	4.35	3.92	4.93	12	8
Percentage of 25–34 year olds with bachelor degree or higher, % [1 3]	14.3	22.2	29.2	30.6	35.8	34.6	34.2	35.0	36.8	35.2	–	35	29.5	40.2	13	8
Proportion of population aged 25–64 attaining tertiary education[1], %	–	27.5	31.7	33.7	36.1	36.9	37.6	38.3	–	–	–	38.3	31.5	45.4	16	9
Proportion of population aged 25–34 with tertiary education[1], %	–	31.4	38.1	40.7	42.0	44.8	44.4	44.6	–	–	–	44.6	38.6	54.7	18	10
Proportion of population aged 25–64 attaining upper secondary or postsecondary nontertiary education[1], %	–	31.3	33.3	34.4	33.8	34.1	35.6	35.7	–	–	–	35.7	44	67.2	47	28
Proportion of population aged 25–64 attaining below upper secondary school education [1], %	–	41.2	35.0	31.8	30.1	29.0	26.8	25.9	–	–	–	25.9	25.2	9.8	164	21
Australia's share of international tertiary education market [1], %	–	5.1	6.5	7.0	6.9	7.0	6.6	6.1	–	–	–	6.1	2.3	9.6	37	5
Proportion of adults scoring at proficiency level 3 or above in literacy, % [4]	–	–	–	–	–	–	–	–	56.4	–	–	56.4	49.9	61.5	8%	5
Percentage of adults scoring at proficiency level 3 or above in numeracy, % [4]	–	–	–	–	–	–	–	–	45.9	–	–	45.9	46.4	57.6	20%	12
Proportion of adults scoring at proficiency level 2 or above in problem solving in technology-rich environments, % [4]	–	–	–	–	–	–	–	–	38.0	–	–	38.0	29.1	41.3	8%	6
VET system expenditure (total expenditure per adjusted full year equivalent (FYTEs)), 2012 prices A$ [5]	–	–	–	–	12,410	11,649	11,859	10,937	10,422	–	–	–	–	–	–	–
Participation rate of Australians aged 15–64 years in VET, % [6]	–	–	11.4	11.3	11.3	11.3	11.8	12.2	12.5	11.9	–	–	–	–	–	–
Number of qualifications completed by students in VET, count in thousands, '000s [6]	–	–	296	319	352	394	444	521	586		–	–	–	–	–	–
Number of qualification equivalents completed by students in VET (Management and commerce) '000s [5]	–	–	127	148	160	158	173	201	215	183	–	–	–	–	–	–
Businesses reporting some or a lot of difficulty in recruiting staff, % of all employers[5]	–	–	40.6	44.4	–	33.7	–	34.1	–	36.4	–	–	–	–	–	–
Employers who use new product releases to determine training needs, % of all employers[6]	–	–	7.1	3.2	–	3.0	–	3.5	–	–	–	–	–	–	–	–
Lack of skilled persons in any location as a barrier to innovation, % [8]	–	–	22.8	23.0	19.4	20.4	20	17.8	–	–	–	–	–	–	–	–

	Australian trend data (i)											OECD comparison				
Indicators	1995	2000	2005	2007	2008	2009	2010	2011	2012	2013	2014	Australia's score (ii)	OECD average (iii)	OECD top 5 average (iv)	Gap from the top 5 OECD performers (%) (v)	Ranking against OECD countries (vi)
Proportion of graduates employed in labour force after completing VET, % [7]	–	–	81	83	82	80	78	79	78	78	–	–	–	–	–	–
VET graduates satisfied with overall quality of training, % [7]	–	–	87	88	88	89	88	89	89	87	–	–	–	–	–	–
Labour force participation rate (Average), % [9]	63.6	63.3	64.5	65.1	65.5	65.5	65.2	65.4	65.2	65	–	–	–	–	–	–
Proportion of employers recruiting international students, % [10]	–	–	15.7	24.1	35.3	20.5	19	30.8	23.2	–	–	–	–	–	–	–
Employer difficulty sourcing/recruiting graduates, %[10]	–	–	49.3	62.4	53.5	30.7	36.3	42.1	34.3	–	–	–	–	–	–	–
Employer overall satisfaction with VET system, % [5]	–	–	70.7	74.0	–	77.8	–	77.8	–	73.1	–	–	–	–	–	–

– = *data not available*

Source: [1] OECD (2013) Education at a Glance. Accessed: 01 Jul 2014. [2] OECD (2003 - 2013) Education at a Glance. 2013. Accessed 2014-07-30. [3] ABS (2005 - 2013) Education and Work, Australia, May 2013, 'Table 8 Persons aged 15–64 years, Level of highest non-school qualification and age–May 2001 to May 2013', data cube: Excel spreadsheet, cat. no. 6227.0. 2013. Accessed 2014-08-14 URL: http://www.abs.gov.au/ausstats/abs@.nsf/mf/6227.0. [4] OECD (2013) Skills Outlook (PIAAC). 2013. Accessed 2014-09-05 URL: http://skills.oecd.org/skillsoutlook.html. [5] NCVER, special data request. [6] NCVER (2009 - 2014) Students and Courses. 2013. Accessed 2014-07-16, www.ncver.edu.au/. [7] NCVER (2013) Student Outcomes. Accessed: 08 Jul 2014, www.ncver.edu.au/. [8] ABS (2008-2013) Selected Characteristics of Australian Business, 2011–12, 'Table 1 Barriers to innovation, by innovation status, by employment size, by industry, 2011-2012', data cube: Excel spreadsheet, cat. no. 8167.0. Accessed: 20 May 2014, www.abs.gov.au/ausstats/abs@.nsf/mf/8167.0ABS. [9] ABS (2014) Labour Force, Australia, 'Table 01. Labour force status by Sex - Trend', data cube: Excel spreadsheet, cat. no. 6202.0. April 2014. Accessed 2014-05-20 URL: http://www.abs.gov.au/ausstats/abs@.nsf/mf/6202.0. [10] Graduate Careers Australia (2014) Graduate Outlook Survey. 2013. Accessed 2014-07-07 URL: http://www.graduatecareers.com.au/research/surveys/graduateoutlooksurvey. [11] NCVER, special data request.

Table notes: (i) Data is presented in calendar year format. Where the data is in financial years, it is expressed in terms of the year where the financial year begins e.g. 2010-11 is shown as 2010. (ii) The 'Australia's score' field presents the Australian values used in the OECD comparisons. (iii) This is the arithmetic (simple) average of the OECD country scores. (iv) This is the arithmetic (simple) average of the top five OECD countries in a ranked list. (v) This represents Australia's distance from the frontier as defined by the average of the top five ranked OECD countries. It is calculated as 100*(Top five average - Australia's score)/ Top 5 average. Where the solution is a negative value or zero, "no gap" is shown in the cell. (vi) OECD rankings are performed on those OECD countries for which data is available. Individual data availability may vary between indicators. "-" = data not available.

8. Research-driven competitiveness

Australia's research sector is a high performer by Organisation for Economic Co-operation and Development (OECD) standards. Better linkages between Australia's research expertise and industrial sectors would lead to improved capabilities for competitiveness in those sectors.

Some fields of research are identified as strengths. Some of these strengths are multidisciplinary or enabling fields of research, and so they are difficult to align with a specific industry. However, some research strengths may not be being translated into an industrial strength. If research commercialisation and industry-research commercialisation were stronger in Australia, and better supported by a larger high-risk capital market, these strengths may be better leveraged into emergent industries.

Research and development *(R&D) covers three activities: basic research, applied research and experimental development. Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view. Applied research is also original investigation undertaken to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective. Experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed.*[305]

305 OECD (2002) *Frascati manual: proposed standard practice for surveys on research and experimental development,* OECD Publishing, p. 30.

8.1 Knowledge generation and research capacity

Both public and private sector R&D contribute to Australia's competitive advantage by creating new knowledge and recombining existing knowledge in new, creative ways.[306]

Australia has demonstrated its capacity to produce radical innovations in wireless technology and medical devices—innovations that had their genesis in basic research. It is difficult to determine the right balance between basic and applied research, as it is time and context specific. Even when the majority of Australian firms are adopters and modifiers of innovations generated elsewhere, Australia needs an innovation system capable of undertaking radical and new-to-world innovation—and basic and applied research underpins this capacity. Chapter 2 showed that public and private sectors investments in R&D complement each other.

8.1.1 Research investment

The data in this section cover research investment (Tables 8.1 and 8.2), research quality (Table 8.3) and research commercialisation (Table 8.4). It shows that overall research quality in Australia is high by OECD standards, but that research investment and commercialisation could be improved.

Australia's Chief Scientist has pointed to some critical weaknesses in Australia's research capacity. He notes that while Australia's research performance is strong in terms of our share of the world's top 1% of highly cited research papers, our average (field weighted) citation rates are below all of them.[307]

Given the low levels of industry–research collaboration, the low proportion of researchers in business and their concentration in the professional, scientific and technical services sector, the high performance of Australia's research sector may represent an untapped resource for competitive, world-first innovation.

Australia's research capacity has traditionally been strongest in its publicly funded research organisations such as universities, CSIRO and medical research institutes. In 2012, Australia's higher education expenditure on R&D (HERD) ranked 9th in the OECD as a percentage of gross domestic product (GDP) (Table 8.1). The Australian Government's total support for science, research and innovation through the Federal Budget and other appropriations was $9.58 billion for 2012–13.[308] This includes expenditure on universities, government research agencies, research grants, research

306 ACOLA (2014) The role of science, research and technology in lifting Australian productivity, Securing Australia's future Project 4 final report, www.acola.org.au.

307 Australia's Chief Scientist Professor Ian Chubb AC, *2014 Jack Beale Lecture,* University of New South Wales, 13 August 2014, www.chiefscientist.gov.au/2014/08/speech-2014-jack-beale-lecture-at-unsw

308 Australian Government (2013) *The Australian Government's 2012–13 science, research and innovation budget tables,* DIICCSRTE, Canberra.

training and industry R&D tax incentives.[309] The government provides 30% of Australia's gross expenditure on R&D (GERD) and a significant proportion of business sector investment is facilitated by government programs such as the R&D tax incentive.

Table 8.1 shows a number of indicators of expenditure on R&D as a proportion of GDP. These R&D intensity ratios are useful for country comparisons; they show, at an aggregate level, a country's scientific research investment, from which inferences can be made about the country's overall capacity for research and knowledge production. Australia's GERD as a proportion of GDP increased from 1.58% in 1996–97 to a peak of 2.25% in 2008–09, which brought it closer to the OECD average of 2.33%. In value (current dollar) terms, Australia's GERD increased substantially from $8.8 billion in 1996–97 to $31.7 billion in 2011–12. Since 2008–09, Australia's GERD intensity has fallen in successive years to 2.13% in 2011–12. This fall from its peak three years earlier has seen Australia's OECD ranking fall from 12th to 15th (Table 8.1).

I get very frustrated by the assumption that innovation has to start with research. I don't want to say there's not a place for research. There absolutely is. But it doesn't have to start there at all. Secondly, it's a small piece. Research is a small piece of the pie. But in Australia in terms of funding and focus it's not. Research should be between 25% and 50% of the focus, money and brain power.

—Stuart Elliott,
Planet Innovation

Australia's HERD was $9.58 billion in 2012–13. Table 8.1 shows that the HERD:GDP ratio increased from 0.55% in 2008–09 to 0.63% in 2012–13. In 2010, Australia ranked 9th in the OECD in this indicator, an improvement from 11th in 2008.[310] Government expenditure on R&D as a percentage of GDP remained at 0.27% in 2010–11 and Australia ranked 12th among the OECD in this measure. In most of the other indicators of public investment in R&D (Table 8.1), Australia ranks in the upper mid-range of the OECD.

8.1.2 Research performance and commercialisation

Table 8.3 shows 11 indicators of Australia's research outputs in terms of publications and citations, compared with other OECD countries. These indicators show a general trend of improvement. For example, Australia's share of world publications has improved 31% between 2004 and 2013 to reach 3.85%.

Australian research has increased the number of fields with higher than world-average citation rates in 2008–2012. Only one field out of 22 was below the world-average citation rate for that field. In terms of total citations per publication and the relative impact of publications, Australia also has shown improvement, but a gap still exists with the top five OECD performers. In indicators of research excellence, such as the share of the top 1% (highly cited) publications, Australia has improved over time and is now ranked 8th in natural sciences and engineering, and 6th in social sciences compared to other OECD countries.

A select number of public research commercialisation outcomes are reported in Table 8.4. A complete overview of research commercialisation data can

309 Australian Government (2012) *The National Survey of Research Commercialisation 2010–2011,* Canberra.

310 See the *Australian Innovation System Report 2012,* Canberra, p. 18, www.industry.gov.au/aisreport

be found in the National Survey of Research Commercialisation.[311] Annual invention disclosures, a formal record of ideas with commercial potential, show strong growth in Australia since 2000 relative to investment in R&D. These rates of invention disclosure are now on par with Europe and trending towards North American levels.[312] Although research commercialisation outcomes from Australian public research institutions generally show positive growth in absolute terms, relative to increasing levels of investment in R&D, many indicators such as patenting, licensing and start-up activity are in decline. These trends are generally consistent with trends in Europe and North America.

8.1.3 Research training

Research skills are particularly important for innovation. As the pace of social and technological change increases, demand will grow for creative researchers who can push the boundaries of knowledge, and assess and adapt new technologies and emerging ideas.[313] Publicly funded research organisations play a fundamental part in training and developing the research workforce and thus enhancing the ability of businesses to conduct R&D.[314] Total full-time equivalent human resources devoted to R&D in Australia in 2008–09 amounted to an estimated 137,000 persons.[315] About 67% were researchers, with the remainder being technicians or other dedicated support staff. The number of human resources devoted to R&D in Australia has risen over time, increasing by 49% during the two decades up to 2008–09 (Table 8.2).[316]

Australia outperforms the OECD average on two indicators: researchers as a percentage of total labour force and R&D personnel as a percentage of total employment (Table 8.2). Australia has a proportion of researchers in its workforce comparable to North American and European nations, but lower than Scandinavian countries.[317] However, there is a highly uneven distribution of researchers, with the majority working in the public sector. Australia's low representation of researchers in business suggests Australia should place more emphasis on a high level of industry–research collaboration in the short to medium term. Australia's industry–research collaboration on innovation is one of the lowest in the OECD.

Human resources devoted to R&D are projected to increase at 3.2% per year to 2020. This growth will be much faster than growth in total

311 Australian Government (2012) *The National Survey of Research Commercialisation 2010–2011,* Canberra.

312 Ibid.

313 Australian Government (2011) *Research skills for an innovative future: a research workforce strategy to cover the decade to 2020 and beyond,* Canberra.

314 Ibid.

315 The ABS has not updated this figure since 2008–09.

316 Australian Government (2011) *Research skills for an innovative future: a research workforce strategy to cover the decade to 2020 and beyond,* Canberra.

317 Pettigrew AG (2012) *Australia's position in the world of science, technology & innovation,* Occasional Paper Series 2, Australia's Chief Scientist, Canberra, p. 1.

employment, which is projected to be 1.5% per year.[318] This growth is predominantly due to an increase in international students, as higher degree by research (HDR) completions by domestic students have been flat for the past eight years.[319] Australia's supply of domestic higher degree–qualified graduates rose by less than 0.7% between 2006 and 2012. Hence migration and retention of international students in Australia will be important to meet the demand for research-qualified staff in the medium term.

Even so, demand by business, academia and government for people with HDR qualifications is projected to outstrip supply by 2020.[320]

A HDR remains the most important training pathway to research and research-related roles in Australia. Australia ranks well at 9th place in the OECD in terms of the HDR graduation rate (Table 8.2). Almost all research training is supported by public funding, although support from industry bodies and employers, community partners and public sector research agencies has increased to just under $1.79 billion in 2011 (the latest data available).[321]

Retirements in the publicly funded research sector, employment growth in research relevant sectors and increasing demand for quality of supply in the training will increase demand for highly skilled researchers.[322] Australia's reliance on international HDR graduates makes the innovation system vulnerable to competition from foreign universities for international students.

8.2 International research collaboration

It is rare for the leaders in a particular field to be found in just one country. Since the major research powers in the world are all located in North America, western Europe and north-east Asia,[323] the ability of Australian universities to leverage international collaboration is critical to our capacity to tap into major knowledge production. International collaboration between research institutions (including universities, and public and private organisations) is, therefore, an important means for Australia to access the global knowledge needed for businesses to compete internationally. Australia is a medium-sized player in international scientific linkages with significant links to the United States (US), in particular, but also the United Kingdom (UK) and China.[324]

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318 Australian Government (2011) *Defining quality for research training in Australia: a consultation paper,* Canberra.

319 Access Economics (2010) *Australia's future research workforce: supply, demand and influence factors,* a report for DIISR, Canberra.

320 Ibid. These projections need to be considered with caution, as they are based on a number of assumptions in three main scenarios: base, low case and high case. A summary of these assumptions are in the Access Economics report, p. 36.

321 Australian Government (2013) R*esearch, higher education, skills and international education,* highlights as at May 2013, Canberra.

322 Frater BJ et al. (2014) *The role of science, research and technology in lifting Australian productivity,* report for the Australian Council of Learned Academies, Melbourne, p. 14.

323 OECD (2013) *OECD science, technology and industry scoreboard 2013,* OECD Publishing, p. 54.

324 OECD (2013) *OECD science, technology and industry scoreboard* 2013, OECD Publishing, p. 59.

Australian researchers perform relatively well in terms of their international research collaboration and connectedness. The proportion of publications with an Australian author that also had at least one non-Australian author illustrates rates of international collaboration. The rate of international collaboration in Australian publications has risen from just 25% in 1993–97 to 47% in 2008–12. This was 2.19 times the world average rate of international collaboration (Table 8.5). At the institutional level, the 23 Australian universities included in the 2014 Leiden Ranking[325] had international collaboration rates of around 40 to 50% (averaging 46%), compared to a world average of 38.6%.

The relative citation impact (number of citations for Australian research as a ratio to the world average citations in that field of research) is one important means by which the potential influence of research on innovation may be measured.[326] Australian researchers participating in internationally collaborative research see higher relative citation impact rates than Australian-author-only publications (the first section of Table 8.6 shows the ratio of relative citation impact for Australia's internationally collaborative publications to the relative citation impact for Australian-only publications).[327] In fact, publications with at least one Australian and one overseas author, on average, achieved 72% more citations in 2008–12 than Australian-only publications. The payoff to citation rates from international collaboration was particularly high in medical and health sciences (78%) and humanities (171%). This is effectively the comparative advantage Australia derives from international collaboration, and expectedly exhibits a mixed pattern with areas of relative domestic research strength gaining less from collaboration than areas of comparative weakness do (the second section of Table 8.6 shows the ratio of Australia's payoff from international collaboration to the world average payoff from international collaboration).

This benefit from international collaboration also holds true when institutions, rather than fields of research, are the unit of analysis. Almost all Australian institutions in the Thomson Reuters InCites™ database show increases in citation rates from international collaboration. Analysis by the OECD[328] has also shown that for most countries, except those with very large and or unusually domestically focused research systems such as the US, a higher proportion of highly cited publications (defined as those in the top 1% by citation rate) in 2006–08 were produced through international collaboration

325 The Leiden Ranking, produced by the Centre for Science and Technology Studies at the University of Leiden in the Netherlands, measures the scientific performance of the 750 major universities worldwide that had the highest publications outputs in the Thomson Reuters Web of ScienceTM from 2009 to 2012: Leiden Ranking 2014, www.leidenranking.com.

326 Aside from raising citation impact, international collaboration also provides other benefits, such as scientists seeking to work with the best in their field, economies of scale, and sharing of effort, shared priorities and problems, geopolitical and cross-cultural bridge-building, and capacity building: Royal Society (2011) *Knowledge, networks and nations: global scientific collaboration in the 21st century*, The Royal Society, pp. 57–62.

327 This correlation between international collaboration and citation impact is also cited in OECD (2013) *OECD science, technology and industry scoreboard 2013,* OECD Publishing, p. 60.

328 OECD (2010) *Measuring innovation: a new perspective,* OECD Publishing, p. 99.

than domestic-only collaboration, and a higher proportion through domestic collaboration than single-author publications. For Australia, internationally collaborative publications were nearly 2.5 times as likely as Australian-only publications to be among the world's most highly cited.

Australia's success in terms of citation impact for its international research stands in contrast to its performance on university–industry collaboration. In the 2014 Leiden Ranking, the average across the 23 listed Australian universities for the percentage of the university's research output generated through collaboration with industry was 3.6%, compared to 7.1% for Switzerland, 6.3% for the US and 5.1% for the world as a whole.[329]

International research collaboration raises Australia's research profile and absorptive capacity for leading-edge knowledge, but does not always lead directly to better innovation performance in terms of business outcomes and competitiveness. An improvement in Australia's relatively underdeveloped research–industry relationships would almost certainly further enhance both academic and non-academic outcomes from international research collaboration (see Chapter 5).

8.2.1 Revealed scientific advantage

Science and innovation are intertwined. Australia's basic and applied research knowledge base is important for driving innovation, particularly world-first innovation, which is linked with exports and competitiveness. It is therefore important to identify research fields where Australia shows comparative advantages that can support innovation.

Revealed scientific advantage *is the ratio of the proportion of a country's research publications that are in a particular field to the proportion of the world's research publications that are in that field. A specialisation value of 1.00 would indicate that the field comprises the same proportion of that country's research output as it does of world output, while 2.00 would indicate that it comprises twice as high a proportion in the country as in the world. It is important to note that it is quite possible, and even common, to have high specialisations in fields that are only a small proportion of publications.*[330]

It is possible to examine research specialisation, or revealed scientific advantage, based on academic publication outputs for fields of

329 The only field of research in which Australian universities have relatively high rates of collaboration with industry is earth and environmental sciences.

330 For instance, in 2008–12, publications in educational sciences were only 1.8% of Australia's total output, but since they were only 0.9% of total world output, Australia had a specialisation of nearly 2.0 in educational sciences.

research.[331] [332] Australia shows a pattern of research specialisation and relative impact that is similar to that of many other advanced English-speaking nations, and quite different from the pattern in continental Europe and emerging economies. Australia's specialisation has been falling in the past two decades in natural sciences, engineering and even agricultural sciences (albeit from a high base), while rising in medical/health, and social sciences and humanities (from an already high base in social sciences; Table 8.7).

Australia's relative citation impact for research (number of citations for Australian research as a ratio to the world-average citations in that field of research during the same period) has been rising steadily in most scientific fields, irrespective of the trend in specialisation (Table 8.7). Australia's overall relative impact has risen by 22%, from barely above world average in 1993–97 to well above world average by 2008–12 (but still below leading advanced nations, including the US, the UK, Canada, Netherlands, France, Germany and Switzerland). Australia has particular strengths in physics, some engineering disciplines, clinical medicine, most agricultural fields and most humanities, and below average impact only in some of the social sciences, such as economics.

Figure 8.1 compares Australia's research specialisation to research influence for a more disaggregated set of 251 fields of research.[333] A key characteristic of Australia's research publications is the inverse correlation between specialisation and influence. There is a strong tendency in Australian research to see an increase in research influence as research specialisation declines. This is, to a great extent, typical of all major science-producing countries, both established and emerging, as well as the next tier. However, the magnitude of the inverse correlation is highest in the US, the UK, Australia and Russia (2008–12 data had correlations of –0.29, –0.26, –0.29 and –0.22, respectively), and, until recently, in Canada. In Australia, the UK and Russia, it is becoming more pronounced. It reflects, in part, the allocation of science funding through government policy and changes in

331 When analysing revealed scientific advantage, it is important to consider academic influence, measured by field-normalised relative impact. Field-normalised relative impact is the ratio for each field of research of the citations per publication in national publications output to the citations per publication in world publications output. Field normalisation is required, because each field of research has its own publication culture, which shows itself in differing publication and raw citation rates, and these are not comparable across fields in any meaningful sense. Greater international collaboration has increased sharing of citations among countries, and the increased volume of research produced by large emerging countries with impact is steadily improving, but still below world average. As a result, it is counterintuitively possible for all major science-producing countries to have rising relative impact, which has been the case in recent years.

332 It is important to note that publications often contain contributions from multiple countries, so there is overlap between countries. For example, a paper co-authored by an Australian and a German will be counted as an output for each country, a phenomenon that is absent from trade.

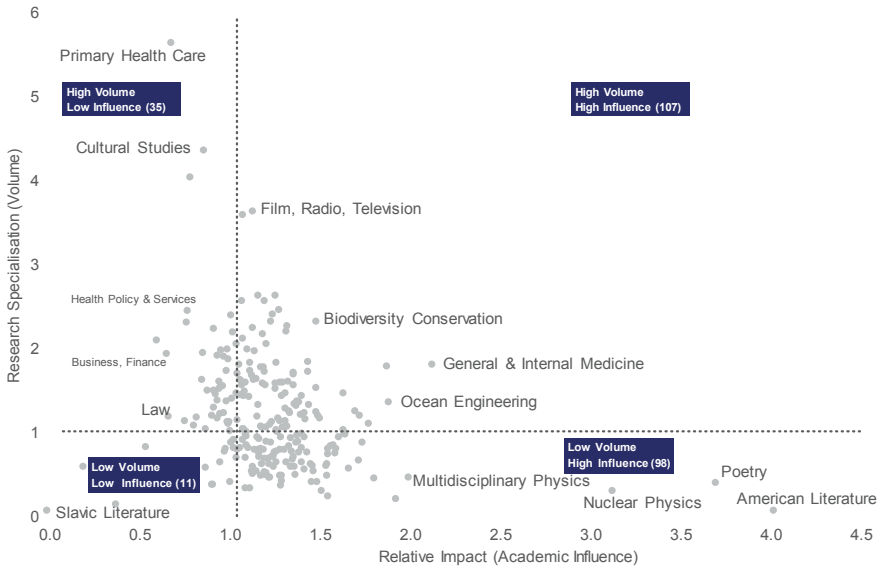
333 Those used by Thomson Reuters in the Web of Science™.

other countries' science priorities.[334] The UK and Australia are two countries that are implementing research excellence and examining possible broader research impact measurements systemically. The UK and Australia also have higher relative impacts than many of the countries, with more positively correlated relationships between research output and impact.

International comparisons show that most developed nations, especially English-speaking ones and also Israel, have higher specialisations in the medical and health sciences, humanities, arts and social sciences, and lower specialisations in the natural sciences, engineering and technology than do emerging economies. continental European countries tend to be towards the middle of the spectrum. This suggests that emerging economies are targeting those fields they feel most relevant to their development and also targeting emerging niche areas where they can compete on equal footing with established scientific powers. This matches the known policy priorities of many of these countries. It also demonstrates that they are achieving their priorities and targets. Leading emerging research powers, such as China, are now major producers by volume, but do not yet achieve relative impacts equal to established powers or even the world average. The exception is Singapore, which rapidly overtook France, Canada, New Zealand, Australia and even the US by 2013.

334 For instance, the English-speaking countries tend to have higher levels of specialisation in the social sciences and humanities. Given the evidence linking the creative economy to innovation (e.g. the many works of Richard Florida) this may indicate that some of the fundamentals to support innovation are healthier in Australia than in many other economies, and it is primarily the poor links between academia and industry that hold us back.

Figure 8.1 Australian research specialisation compared against relative impact, by Thomson Reuters Web of Science Field of Research, 2008–12



Note: For clarity, the boundary of tight dense clusters of data points within a broader classification is used for some fields of research in place of the individual data points, with outliers from these clusters shown by individual data points. To avoid cluttering, many of the fields are not plotted individually, but instead the area covered by most or all of the fields in particular categories is mapped by the boundary of the points.

Source: Thomson Reuters (2012) InCitesTM, report created 6 April 2014.

8.3 Links between Australia's research strengths and its industrial strengths

Experimental development is built upon a foundation of basic and applied research. It is therefore instructive to compare Australia's research specialisation, or revealed scientific advantage, with the relevant areas of industrial specialisation discussed in Chapter 3. Unfortunately, the way both datasets are collected and classified means that we cannot directly align research specialisation with revealed comparative advantage (RCA). It is also important to note that some areas of research, such as psychology, chemistry and physics, have a very broad range of applications. Nevertheless there are a number of interesting observations arising from the data comparison.

The international competitiveness of Australia's agriculture, forestry and fishing sector is still high, but has declined since 1998–2002 (Chapter 3). Table 8.7 shows Australia's research specialisation in agriculture also declined during this period. Innovative agriculture, forestry and fishing businesses are particularly research driven.[335] The agriculture sector has

335 See the *Australian Innovation System Report 2013,* Canberra, p. 118, www.industry.gov.au/aisreport.

benefited from strong, long-standing institutional support for applied research through Rural Research and Development Corporations. It is possible that, in the medium to long term, the falling research specialisation in this field has affected the sectors' competiveness.

The mining sector has high R&D intensities (Figure A.18) and is a heavy user of research skills.[336] Innovative mining businesses are much more likely to collaborate than non-innovative mining businesses, particularly in joint R&D, which is almost three times more likely.[337] Australia's scientific strengths in the earth and related environmental sciences (Table 8.7) will have provided strong support to the mining industry. Although still high, there has been a recent decline in research specialisation in this field. Research impact in this sector has not declined, suggesting that other, probably resource-dependent, developing countries are producing more research papers in this field.

As seen in Table 3.2, export specialisation is very low in nearly all manufacturing industries and has been declining during the past decade. Research specialisation is also quite low and/or declining in many manufacturing-relevant research fields of biotechnology, nanotechnology and engineering (Table 8.7). Historically, these fields of research may not have been as heavily oriented towards academic publication, and so research output may be artificially low. Innovative manufacturers are ten times more likely to use research skills as core businesses than non-innovative manufacturers.[338] In many of these fields, research quality is above world average and relative rates of research collaboration are higher than most of the natural sciences (Tables 8.6 and 8.7). Greater collaboration between these fields of research and the manufacturing sector may therefore lift the international competitiveness of the sector in general.

Even the exceptional industries of food and basic metals manufacturing with a high RCA have lost significant margins in the past 15 years. Food and beverages manufacturing could expect to benefit from Australia's research specialisation in agricultural sciences, particularly animal and dairy science, from chemical and biological sciences, and chemicals and materials engineering. However, all of these research fields have declined in specialisation in the past 15 years, particularly animal and dairy science, with only biological science holding its high scientific advantage.

The international competitiveness of Australia's niche manufacturing of medical instruments sector has improved, and exports have grown from a low base in the past 15 years to reach $7.5 billion in 2008–12 (Table 3.2). At the same time, medical engineering research, and health and medical research have become more specialised (Table 8.7). Many well-known case studies, such as Cook Medical, Cochlear and ResMed, confirm Australia's

336 Ibid.

337 ABS (2013) *Selected characteristics of Australian business,* 2011–12, cat. no. 8167.0, Canberra.

338 See the *Australian Innovation System Report 2013,* Canberra, p. 118 www.industry.gov.au/aisreport.

When we do research it should be driven by the development, not the other way around.

—Stuart Elliott, Planet Innovation

science-driven success in this industry sector, which has high rates of innovation compared with the rest of Australian manufacturing (Table 2.2). However, RCA (Chapter 3) is still less than one, suggesting that this sector faces high international competition. The declining rate of start-up formation from public sector research organisations, low rates of venture capital investment and the ongoing buyout of technology advancements by foreign multinationals may impede the growth of this sector domestically.

Research specialisation can give an indication of a growing research capability that could underpin new or nascent industries. Environmental engineering, industrial biotechnology, nanotechnology, economics, business and art all show high or growing research specialisation between 1997 and 2012 (Table 8.7).[339] The OECD has also identified that Australia has strengths in general environmental management technology and technology specific to climate change mitigation ranking 1st and 2nd, respectively in the world share of Patent Cooperation Treaty patents.[340]

339 Further research is required into each separate research field to see how integrated it is into their respective industries. This may be sometimes difficult to track where technologies emerging from biotechnology or nanotechnology research benefit multiple sectors.

340 See *OECD STI scoreboard,* p. 155, www.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-scoreboard-2013_sti_scoreboard-2013-en. Data relate to patent applications filed under the Patent Cooperation Treaty (PCT). Patent counts are based on the priority date, the inventor's residence and fractional counts. Patents in environment-related technologies are defined using combinations of IPC classes and codes Y02 of the European Classification (ECLA), as detailed in www.oecd.org/env/consumption-innovation/indicator.htm. Only economies that applied for more than 250 patents in 2008–10 are included. For technology fields based on ECLA codes, data for 2008–10 are underestimated.

Table 8.1 Australia's investment in research

	Australian Trend Data (i)										OECD Comparisons				
Indicators	1995	2000	2005	2007	2008	2009	2010	2011	2012	2013	Australia's score (ii)	OECD average (iii)	OECD top 5 average (iv)	Gap from the top 5 OECD performers (%)(v)	Ranking against OECD countries (vi)
Gross Expenditure on R&D (GERD), % of GDP [1 (a)]	1.51	1.48	1.73	–	2.25	–	2.19	2.13	–	–	2.13	2.01	3.72	42.67	15
Gross Expenditure on R&D (GERD), billion A$ [2, 4]	7.5	10.4	16.0	–	28.3	–	30.9	31.7	–	–	–	–	–	–	–
Gross Expenditure on R&D (GERD) per capita population, current PPP $ [1 (a)]	320	412	577	–	881	–	913	–	–	–	913	723	1317	31	12
Business Expenditure on R&D (BERD), billion A$ [3]	4.36	4.98	10.4	15.1	17.3	16.8	18.0	18.3	–	–	–	–	–	–	–
Higher Education Expenditure on R&D (HERD), % of GDP [1 (b)]	0.39	0.40	0.47	–	0.54	–	0.58	–	0.63	–	0.63	0.50	0.85	25.77	9
Higher Education Expenditure on R&D (HERD), billion A$ [4 (a)]	1.8	2.8	4.3	–	6.8	–	8.2	–	9.6	–	–	–	–	–	–
Higher Education Expenditure on R&D (HERD) financed abroad, % [4 (a)]	1.01	2.17	2.96	–	2.03	–	2.2	–	2.4	–	–	–	–	–	–
Percentage of Higher Education Expenditure on R&D (HERD) financed by industry, % [1(a)]	4.66	5.32	6.20	–	5.85	–	4.89	–	–	–	4.89	5.92	13.41	63.50	13
Government Expenditure on R&D (GOVERD), % of GDP [1 (a)]	0.40	0.33	0.27	–	0.27	–	0.27	0.24	–	–	0.24	0.22	0.41	42.30	15
Government Expenditure on R&D (GOVERD), billion A$ [5 (a)]	2.0	2.4	2.5	–	3.4	–	–	3.5	3.7	–	–	–	–	–	–
Percentage of Government Expenditure on R&D (GOVERD) financed by industry, % [1(a)]	11.6	12.3	13.6	–	9.93	–	–	7.12	–	–	7.1	6.3	13.9	48.6	12
Public spending in environment-related R&D, % of total public spending on R&D [1]	1.19	2.95	3.18	3.81	3.57	5.47	5.01	4.86	–	–	4.9	2.4	4.5	no gap	2
Percentage of Gross Expenditure on R&D (GERD) performed by the Private Non-Profit sector, % [1 (a)]	2.05	2.77	3.00	–	2.63	–	2.97	–	–	–	3.0	2.8	9.9	70	5
Private Non-profit R&D, million A$ [5 (a)]	153	289	479	–	744	–	–	925	–	–	–	–	–	–	–
Government Budget Appropriations or Outlays for R&D (GBAORD), % of GDP [1]	0.57	0.53	0.52	0.46	0.45	0.5	0.49	0.48	0.46	0.44	0.4	0.7	1	56.2	19
Government–financed Gross Expenditure on R&D (GERD), % of GDP [1 (a)]	0.71	0.67	0.70	–	0.78	–	–	–	–	–	0.8	0.6	0.9	14.3	7

– = *data not available*

Table notes: (i) Data are presented in calendar year format. Where the data are in financial years, it is expressed in terms of the year where the financial year begins e.g. 2010–11 is shown as 2010. (ii) The 'Australia's score' field presents the Australian values used in the OECD comparisons. (iii) This is the arithmetic (simple) average of the OECD country scores. (iv) This is the arithmetic (simple) average of the top five OECD countries in a ranked list. (v) This represents Australia's distance from the frontier as defined by the average of the top five ranked OECD countries. It is calculated as 100*(Top five average - Australia's score)/ Top 5 average. Where the solution is a negative value or zero, 'no gap' is shown in the cell. (vi) OECD rankings are performed on those OECD countries for which data are available. Individual data availability may vary between indicators.

Indicator notes: (a) 1994 data are used in the absence of 1995 data; 2004 data are used in the absence of 2005 data. (b) 2004 data are used in the absence of 2005 data

Sources: [1] OECD (2014) Main Science and Technology Indicators, 2014-1. [2] ABS (2010) Research and Experimental Development, All Sector Summary, Australia, 2008–09, cat. no. 8112.0 [3] ABS (2013) Research and Experimental Development, Businesses, Australia, 2011–12, cat. no. 8104.0 [4] ABS (2014) Research and Experimental Development, Higher Education Organisations, Australia, 2010, cat. no. 8111.0. [5] ABS (2014) Research and Experimental Development, Government and Private Non-Profit Organisations, Australia, 2012–13, cat. no. 8109.0.

Table 8.2 Indicators of Australia's research workforce

	Australian Trend Data (i)										OECD Comparisons				
Indicators	1995	2000	2005	2007	2008	2009	2010	2011	2012	2013	Australia's score (ii)	OECD average (iii)	OECD top 5 average (iv)	Gap from the top 5 OECD performers (%) (v)	Ranking against OECD countries (vi)
Share of professionals and technicians in total employment, % [4]	–	–	37.6	35.8	–	36.1	–	–	–	–	36.1	31.8	42.4	15	9
Number of students completing higher degree by research in Australia [1]	–	5,434	6,820	7,141	7,178	7,092	7,403	7,961	8,230	9,209	–	–	–	–	–
Number of domestic students completing higher degree by research in Australia [1]	–	4,557	5,510	5,506	5,556	5,382	5,460	5,647	5,601	6,165	–	–	–	–	–
Number of international students completing higher degree by research in Australia [1]	–	877	1,310	1,635	1,622	1,710	1,943	2,314	2,629	3,044	–	–	–	–	–
PhD graduation rate, % [2]	–	1.29	1.82	1.91	1.89	1.85	1.89	–	–	–	1.89	1.57	2.91	35	9
Proportion of international students enrolled in advanced research programs, % [2]	–	–	17.8	20.8	23.3	26.3	28.7	30.7	–	–	30.71	18.34	41.66	26	6
Researchers, % of total labour force [3 (a)]	0.65	0.69	0.80	–	0.82	–	–	–	–	–	0.82	0.7	1.19	31	9
R&D personnel, % of total employment [3 (a)]	1.08	1.06	1.19	–	1.26	–	–	–	–	–	1.26	1.16	1.83	31	14
Availability of research and training services, 1–7 (best), score [5 (b)]	–	–	5.31	5.20	5.27	5.28	5.26	5.39	5.32	5.07	5.07	5.12	6.14	17	16

– = *data not available*

Table notes: (i) Data are presented in calendar year format. Where the data are in financial years, it is expressed in terms of the year where the financial year begins e.g. 2010–11 is shown as 2010. (ii) The 'Australia's score' field presents the Australian values used in the OECD comparisons. (iii) This is the arithmetic (simple) average of the OECD country scores. (iv) This is the arithmetic (simple) average of the top five OECD countries in a ranked list. (v) This represents Australia's distance from the frontier as defined by the average of the top five ranked OECD countries. It is calculated as 100*(Top five average - Australia's score)/ Top 5 average. Where the solution is a negative value or zero, 'no gap' is shown in the cell. (vi) OECD rankings are performed on those OECD countries for which data are available. Individual data availability may vary between indicators.

Indicator notes: (a) Since 2008–09 the ABS has not published this figure. (b) For this indicator, survey respondents were asked to answer the question 'In your country, to what extent are high-quality, specialised training services available? [1 = not available; 7 = widely available]'

Sources: [1] Higher Education Information management System student data collection, published and unpublished data. [2] OECD (various) Education at a Glance. [3] OECD Main Science and Technology Indicators database, 2013/1. [4] OECD (various) Science, Technology and Industry Scoreboard. [5] WEF World Economic Forum (various) The Global Competitiveness Report.

Table 8.3 Quality measures of Australia's research publications

	Australian Trend Data (i)											OECD Comparisons				
Indicators	1995	2000	2005	2007	2008	2009	2010	2011	2012	2013	2014	Australia's score (ii)	OECD average (iii)	OECD top 5 average (iv)	Gap from the top 5 OECD performers (%)(v)	Ranking against OECD countries (vi)
Share of world publications, % [1 (a)]	2.45	2.77	2.88	2.97	3.03	3.1	3.19	3.29	3.39	–	–	3.59	2.84	10.99	67.33	9
Number of fields with higher than world average citation rate by field [1(a)]	10	13	16	17	18	18	19	21	21	–	–	–	–	–	–	–
Citations per publication, count [1(a)]	3.08	3.90	4.94	5.29	5.57	5.75	6.01	6.24	6.49	–	–	6.36	6.4	8.86	28.22	19
Share of world's top 1% highly cited publications, All disciplines, % [1 (b)]	–	–	3.6	4	4.43	4.77	5.02	5.4	5.88	6.27	–	6.27	4.5	17.89	64.94	7
Share of world's top 1% highly cited publications, Natural Sciences and Engineering, % [1 (b)]	–	–	3.64	4.04	4.48	4.8	5.04	5.41	5.88	6.19	–	6.19	4.51	17.81	65.24	7
Share of world's top 1% highly cited publications, Social Science and Humanities, % [1 (b)]	–	–	2.89	3.09	3.67	4.32	4.8	5.08	5.87	7.51	–	7.51	4.29	19.58	61.66	6
Share of world's top 1% highly cited publications attributed to domestic research, All disciplines, % [1 (b) (c)]	–	–	1.12	1.27	1.42	1.43	1.39	1.38	1.4	1.55	–	1.55	1.39	6.81	77.28	7
Share of world's top 1% highly cited publications attributed to domestic research, Natural Sciences and Engineering, % [1 (b) (c)]	–	–	1.13	1.29	1.43	1.42	1.37	1.37	1.38	1.48	–	1.48	1.36	6.67	77.75	8
Share of world's top 1% highly cited publications attributed to domestic research, Social Science and Humanities, % [1 (b) (c)]	–	–	0.94	0.92	1.27	1.58	1.71	1.53	1.75	2.56	–	2.56	1.73	9.65	73.47	3
Share of world's top 1% highly cited publications attributed to international collaboration, All disciplines, % [1 (b) (d)]	–	–	2.48	2.72	3.01	3.35	3.64	4.02	4.49	4.72	–	4.72	3.11	11.12	57.52	8
Share of world's top 1% highly cited publications attributed to international collaboration, Natural Sciences and Engineering, % [1 (b) (d)]	–	–	2.51	2.75	3.05	3.38	3.67	4.05	4.51	4.71	–	4.71	3.15	11.2	57.96	8
Share of world's top 1% highly cited publications attributed to international collaboration, Social Science and Humanities, % [1 ii,iv]	–	–	1.95	2.17	2.4	2.75	3.09	3.55	4.13	4.95	–	4.95	2.55	10.06	50.84	6

– = data not available.

Table notes: (i) Data are presented in calendar year format. Where the data are in financial years, it is expressed in terms of the year where the financial year begins e.g. 2010–11 is shown as 2010. (ii) The 'Australia's score' field presents the Australian values used in the OECD comparisons. (iii) This is the arithmetic (simple) average of the OECD country scores. (iv) This is the arithmetic (simple) average of the top five OECD countries in a ranked list. (v) This represents Australia's distance from the frontier as defined by the average of the top five ranked OECD countries. It is calculated as 100*(Top five average - Australia's score)/ Top 5 average. Where the solution is a negative value or zero, 'no gap' is shown in the cell. (vi) OECD rankings are performed on those OECD countries for which data are available. Individual data availability may vary between indicators.

Indicator notes: (a) Data cover a five year period e.g. 2012 data covers 2008-2012 inclusive. (b) Data covers a three year period e.g. 2013 data covers 2011-2013 inclusive. Percent of world top publications produced by Australian authors. Top publications means papers (articles and reviews) that rank in the top 1% by citations for field and year. (c) Domestic means without international collaboration. (d) International means through international collaboration (at least one non-Australian co-author).

Sources: [1] InCites™, Thomson Reuters (2014)

Table 8.4 Research commercialisation outcomes

Australian Trend Data											
Indicators	**1995**	**2000**	**2005**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Number of formal agreements on academic/research collaboration between Australian universities and overseas institutions [1, a]	–	3,089	3,054	3,421	–	3,493	–	–	5,086	–	8,515
Adjusted gross income from Licenses, Options and Assignments by publicly funded research agencies and universities, million A$ [2, b]	–	136	117	238	94	315	146	91	–	–	–
Gross income from contracted research and consultancies by publicly funded research agencies and universities, billion AU$ [2, b]	–	–	1.31	1.4	1.26	1.24	1.48	1.36	–	–	–
Number of start-up companies in which publicly funded research agencies and universities have an equity holding [2]	–	66	154	178	173	176	165	166	–	–	–
Number of Australian patent and plant breeder rights filed by publicly funded research agencies and universities [2]	–	533	462	470	567	645	673	669	–	–	–
Number of LOAs yielding income from publicly funded research agencies and universities [2]	–	472	537	587	523	580	742	721	–	–	–
University income from Cooperative Research Centre (CRC) Research, million AU$ [3]	–	81	130	126	124	123	119	108	–	–	–
University income from industry, million AU$ [3]	–	331	492	672	773	666	797	832	–	–	–

– = data not available

Indicator notes: (a) For 2000 and 2005, the 2001 and 2003 figures were used respectively. (b) All figures are in constant 2011 prices.

Sources: [1] Universities Australia (various) International Links of Australian Universities. [2] DIISRTE (2012) National Survey of Research Commercialisation 2010–11. [3] Higher Education Research Data Collection, 2011.

Table 8.5 Australian absolute and relative international collaboration rates, by Frascati Field of Research, by 5-year period, 1993–97, 1998–2002, 2003–07 and 2008–12

Australia	International Collaboration Rate				Relative Collaboration Rate			
Subject Area	1997	2002	2007	2012	1997	2002	2007	2012
NATIONAL TOTAL	24.59	35.33	41.20	47.15	1.96	2.07	2.12	2.19
1 NATURAL SCIENCES	30.98	43.01	48.08	56.46	1.92	2.00	2.08	2.23
1.01 Mathematics	41.36	49.91	55.05	61.42	2.19	2.06	2.18	2.32
1.02 Computer and Information Sciences	26.80	39.98	39.60	55.08	2.11	2.28	2.18	2.30
1.03 Physical Sciences and Astronomy	40.83	55.02	58.47	66.18	1.91	2.00	2.12	2.32
1.04 Chemical Sciences	26.28	36.04	42.55	50.52	2.11	2.24	2.48	2.66
1.05 Earth and Related Environmental Sciences	29.13	43.36	49.85	55.87	1.88	1.85	1.84	1.87
1.06 Biological Sciences	26.78	38.55	44.56	52.58	1.79	1.88	1.89	2.00
1.07 Other Natural Sciences	23.93	47.64	66.67	71.12	2.25	2.72	2.58	2.30
2 ENGINEERING AND TECHNOLOGY	24.87	35.31	42.45	50.23	2.16	2.17	2.34	2.50
2.01 Civil Engineering	20.98	30.74	43.60	46.98	1.89	2.22	2.49	2.29
2.02 Electrical and Electronic Engineering	26.85	41.52	47.60	56.38	2.61	2.66	2.69	2.69
2.03 Mechanical Engineering	30.24	39.34	45.19	50.63	2.49	2.28	2.32	2.53
2.04 Chemical Engineering	22.18	30.20	35.66	42.71	2.42	2.34	2.39	2.52
2.05 Materials Engineering	25.09	35.63	45.15	54.30	1.89	1.99	2.44	2.72
2.06 Medical Engineering	22.43	33.47	36.38	45.54	2.29	2.39	2.12	2.21
2.07 Environmental Engineering	21.71	30.93	40.13	47.18	2.11	1.97	2.19	2.30
2.08 Environmental Biotechnology	27.74	38.02	43.70	50.44	2.11	2.24	2.31	2.43
2.09 Industrial Biotechnology	35.38	38.35	47.23	47.09	2.56	2.22	2.37	2.09
2.10 Nano-Technology	27.73	43.27	48.47	57.49	2.46	2.11	2.33	2.43
2.11 Other Engineering and Technologies	23.20	29.88	38.18	47.17	2.07	1.90	2.11	2.36
3 MEDICAL AND HEALTH SCIENCES	19.94	30.18	36.99	43.07	2.01	2.19	2.20	2.21
3.01 Basic Medical Research	23.19	32.84	40.53	47.52	1.87	1.98	2.11	2.20
3.02 Clinical Medicine	18.36	29.45	36.30	44.28	2.18	2.41	2.35	2.45
3.03 Health Sciences	20.61	28.20	35.17	37.94	1.93	1.92	1.93	1.77
4 AGRICULTURAL SCIENCES	17.20	28.26	33.08	42.13	1.87	1.90	1.87	2.16
4.01 Agriculture, Forestry, Fisheries	16.29	27.70	31.69	40.86	1.57	1.60	1.53	1.91
4.02 Animal and Dairy Science	18.80	26.39	37.27	47.13	2.12	1.83	2.19	2.32
4.03 Veterinary Science	18.07	33.05	35.28	42.12	2.12	2.49	2.40	2.38
4.05 Other Agricultural Science	17.34	23.29	32.75	42.90	2.13	1.82	2.00	2.29
5 SOCIAL SCIENCES	18.29	26.22	31.42	34.45	2.40	2.42	2.20	1.88
5.01 Psychology	19.35	30.15	37.30	43.83	2.40	2.46	2.30	2.10
5.02 Economics and Business	27.86	37.71	40.86	45.20	2.31	2.28	1.96	1.79
5.03 Educational Sciences	15.31	18.77	22.76	22.37	4.16	3.91	3.26	2.13
5.04 Sociology	17.41	19.50	24.34	28.52	2.56	2.18	2.12	1.87
5.05 Law	14.98	19.81	24.56	25.00	6.49	5.69	4.47	2.95
5.06 Political Science	11.51	13.12	18.29	24.64	2.25	2.05	2.14	1.94
5.07 Social and Economic Geography	13.20	22.05	24.38	29.99	1.72	2.06	1.75	1.61
5.08 Media and Communication	17.59	29.95	30.69	21.40	4.00	4.23	3.17	1.51
5.09 Other Social Sciences	14.71	18.53	22.98	25.83	3.02	2.97	2.61	2.04
6 HUMANITIES	5.43	8.00	11.26	17.66	2.76	3.03	2.79	2.55
6.01 History and Archaeology	8.07	7.58	11.58	17.92	2.90	2.09	2.15	2.24
6.02 Languages and Literature	4.06	7.94	11.53	20.03	2.07	2.78	2.90	2.97
6.03 Philosophy, Ethics and Religion	4.47	10.17	13.65	20.65	2.81	5.10	4.02	3.30
6.04 Art	4.74	5.00	4.52	10.25	4.14	2.79	1.43	1.39
6.05 Other Humanities	3.09	1.00	5.65	9.72	2.25	0.83	2.60	2.18

Note: Years in the table are the end years of the non-overlapping five year periods analysed.

Source: Thomson Reuters (2012) InCitesTM, report created 14 May 2014.

Table 8.6 Australian absolute and relative citation impact benefits from international collaboration, by Frascati Field of Research, by 5-year period, 1993–97, 1998–2002, 2003–07 and 2008–12

Australia	Citation Ratio Int'l/Domestic				Comparative Collaborative Advantage			
Subject Area	1997	2002	2007	2012	1997	2002	2007	2012
NATIONAL TOTAL	1.76	1.70	1.70	1.72	1.19	1.17	1.20	1.15
1 NATURAL SCIENCES	1.58	1.47	1.50	1.48	1.22	1.13	1.14	1.10
1.01 Mathematics	1.22	1.24	1.59	1.31	0.85	0.91	1.20	0.99
1.02 Computer and Information Sciences	1.29	1.36	1.71	1.09	1.05	1.07	1.24	0.92
1.03 Physical Sciences and Astronomy	1.55	1.97	1.76	1.79	1.13	1.34	1.17	1.14
1.04 Chemical Sciences	1.18	1.01	1.10	1.18	1.04	0.89	0.99	1.00
1.05 Earth and Related Environmental Sciences	1.58	1.50	1.50	1.40	1.22	1.16	1.13	1.03
1.06 Biological Sciences	1.76	1.47	1.45	1.49	1.35	1.19	1.20	1.13
1.07 Other Natural Sciences	6.56	1.38	4.39	3.82	2.47	0.81	2.77	2.14
2 ENGINEERING AND TECHNOLOGY	1.41	1.24	1.36	1.19	1.06	0.98	1.10	0.93
2.01 Civil Engineering	1.19	1.25	1.13	1.05	0.96	0.96	0.90	0.95
2.02 Electrical and Electronic Engineering	1.26	1.32	1.34	1.19	0.99	1.05	1.04	0.89
2.03 Mechanical Engineering	1.58	1.07	1.54	1.18	1.01	0.78	1.12	0.90
2.04 Chemical Engineering	0.86	0.83	1.21	1.02	0.71	0.66	0.99	0.85
2.05 Materials Engineering	1.32	1.20	1.02	1.22	1.11	1.01	0.87	0.94
2.06 Medical Engineering	1.10	1.27	1.55	1.22	0.94	1.02	1.34	0.93
2.07 Environmental Engineering	1.18	1.29	1.20	1.22	0.90	0.97	1.00	1.12
2.08 Environmental Biotechnology	1.86	1.25	1.85	1.24	1.30	0.93	1.52	0.95
2.09 Industrial Biotechnology	0.42	0.86	1.37	0.79	0.40	0.83	1.34	0.74
2.10 Nano-Technology	0.98	1.14	1.03	1.11	1.01	1.16	1.10	1.01
2.11 Other Engineering and Technologies	1.40	1.38	1.39	1.15	1.02	1.07	1.10	0.90
3 MEDICAL AND HEALTH SCIENCES	1.79	1.82	1.82	1.78	1.13	1.18	1.24	1.13
3.01 Basic Medical Research	1.84	1.46	1.49	1.40	1.33	1.05	1.13	1.02
3.02 Clinical Medicine	1.81	2.01	1.97	1.93	1.06	1.23	1.24	1.12
3.03 Health Sciences	1.45	1.52	1.57	1.57	0.99	1.05	1.14	1.08
4 AGRICULTURAL SCIENCES	1.35	1.20	1.17	1.16	1.00	0.89	0.88	0.85
4.01 Agriculture, Forestry, Fisheries	1.41	1.05	1.13	1.19	0.98	0.79	0.87	0.80
4.02 Animal and Dairy Science	1.23	2.05	1.33	1.01	1.02	1.63	0.99	0.72
4.03 Veterinary Science	1.34	1.23	1.13	1.40	0.95	0.79	0.74	0.95
4.05 Other Agricultural Science	1.42	1.57	1.53	0.99	1.25	1.35	1.28	0.83
5 SOCIAL SCIENCES	1.63	1.60	1.65	1.67	1.31	1.19	1.23	1.23
5.01 Psychology	1.30	1.50	1.36	1.36	1.06	1.14	1.11	1.13
5.02 Economics and Business	1.71	1.37	1.52	1.53	1.51	1.13	1.26	1.25
5.03 Educational Sciences	1.18	1.13	1.43	1.59	0.97	0.92	1.06	1.23
5.04 Sociology	2.38	1.84	2.08	1.99	1.65	1.33	1.45	1.33
5.05 Law	1.33	0.81	1.52	2.01	1.82	0.89	1.52	1.72
5.06 Political Science	2.48	1.77	1.96	1.74	1.82	1.62	1.48	1.31
5.07 Social and Economic Geography	1.98	1.52	1.62	1.62	1.71	1.28	1.21	1.20
5.08 Media and Communication	1.40	1.82	2.35	1.60	1.05	1.40	1.52	1.15
5.09 Other Social Sciences	2.18	2.20	1.63	1.51	1.40	1.48	1.08	0.96
6 HUMANITIES	2.93	3.45	2.73	2.71	0.90	0.99	0.84	0.97
6.01 History and Archaeology	3.01	4.85	2.54	3.25	1.20	2.02	0.95	1.14
6.02 Languages and Literature	5.09	2.73	3.34	2.53	1.12	0.58	0.80	0.77
6.03 Philosophy, Ethics and Religion	0.45	2.61	1.99	1.91	0.33	1.14	0.95	0.91
6.04 Art	8.91	2.68	0.89	2.38	3.69	0.84	0.24	1.18
6.05 Other Humanities	0.00	31.50	3.43	1.62	0.00	12.85	1.60	0.79

Note: Years in the table are the end years of the non-overlapping five year periods analysed: '1997' covers the whole period 1 January 1993 to 31 December 1997

Numbers indicated in red are significantly below the world average for that period. Numbers indicated in green are significantly above the world average for that period.

Source: Thomson Reuters (2012) InCites™, report created 14 May 2014.

Table 8.7 Australian research specialisation and relative impact, by Frascati Field of Research, by 5-year period, 1993–97, 1998–2002, 2003–07 and 2008–12

Australian trend data	Research specialisation				Relative Impact of research			
Subject Area	1997	2002	2007	2012	1997	2002	2007	2012
NATIONAL TOTAL	1.00	1.00	1.00	1.00	1.03	1.11	1.18	1.26
1 NATURAL SCIENCES	0.95	0.94	0.91	0.87	1.06	1.14	1.17	1.31
1.01 Mathematics	1.07	0.95	0.78	0.63	1.10	1.03	1.28	1.20
1.02 Computer and Information Sciences	1.09	1.06	1.00	0.89	0.87	0.93	1.05	1.13
1.03 Physical Sciences and Astronomy	0.68	0.64	0.64	0.65	1.13	1.30	1.29	1.53
1.04 Chemical Sciences	0.62	0.57	0.53	0.53	1.15	1.13	1.12	1.28
1.05 Earth and Related Environmental Sciences	1.57	1.62	1.56	1.46	1.21	1.26	1.24	1.27
1.06 Biological Sciences	1.21	1.25	1.25	1.17	0.91	0.98	1.03	1.19
1.07 Other Natural Sciences	0.62	0.66	0.91	1.04	0.86	0.84	1.36	1.64
2 ENGINEERING AND TECHNOLOGY	0.80	0.77	0.73	0.73	1.19	1.17	1.21	1.30
2.01 Civil Engineering	1.48	1.22	1.10	1.05	1.17	1.29	1.28	1.05
2.02 Electrical and Electronic Engineering	0.78	0.76	0.68	0.68	1.22	1.20	1.22	1.43
2.03 Mechanical Engineering	0.72	0.71	0.64	0.57	1.26	1.26	1.21	1.35
2.04 Chemical Engineering	0.83	0.83	0.81	0.83	1.20	1.30	1.13	1.19
2.05 Materials Engineering	0.64	0.60	0.58	0.63	1.27	1.18	1.18	1.38
2.06 Medical Engineering	0.71	0.80	0.83	0.92	1.21	1.04	1.06	1.16
2.07 Environmental Engineering	1.14	1.24	1.10	1.05	1.00	1.07	1.06	1.07
2.08 Environmental Biotechnology	0.92	0.82	0.80	0.73	1.08	1.05	1.31	1.25
2.09 Industrial Biotechnology	0.54	0.69	0.68	0.79	1.16	1.03	0.94	1.27
2.10 Nano-Technology	0.37	0.53	0.56	0.65	1.07	0.92	1.01	1.23
2.11 Other Engineering and Technologies	0.82	0.83	0.74	0.68	1.16	1.07	1.13	1.31
3 MEDICAL AND HEALTH SCIENCES	1.00	1.04	1.11	1.15	1.03	1.10	1.18	1.23
3.01 Basic Medical Research	0.95	0.99	0.99	0.94	1.00	1.03	1.07	1.19
3.02 Clinical Medicine	0.98	0.99	1.07	1.08	1.07	1.18	1.28	1.38
3.03 Health Sciences	1.32	1.43	1.67	1.90	1.13	1.11	1.11	1.08
4 AGRICULTURAL SCIENCES	1.83	1.58	1.40	1.10	1.18	1.19	1.18	1.35
4.01 Agriculture, Forestry, Fisheries	2.50	2.16	2.02	1.50	1.16	1.17	1.15	1.45
4.02 Animal and Dairy Science	1.92	1.61	1.09	0.86	0.91	0.91	1.21	1.59
4.03 Veterinary Science	1.60	1.18	1.04	0.98	1.17	1.27	1.33	1.38
4.05 Other Agricultural Science	0.90	0.94	0.85	0.72	1.11	0.96	1.02	1.13
5 SOCIAL SCIENCES	1.27	1.35	1.42	1.62	0.78	0.87	0.95	0.97
5.01 Psychology	1.22	1.44	1.50	1.55	0.83	0.92	0.97	0.98
5.02 Economics and Business	1.15	1.31	1.38	1.53	0.69	0.74	0.84	0.89
5.03 Educational Sciences	1.53	1.50	1.62	1.95	1.11	1.20	1.12	1.05
5.04 Sociology	1.32	1.26	1.37	1.58	0.87	0.85	0.98	1.05
5.05 Law	0.65	0.76	1.01	1.35	0.64	0.93	0.92	0.80
5.06 Political Science	1.65	1.48	1.41	1.43	0.45	0.61	0.67	0.95
5.07 Social and Economic Geography	1.63	1.64	1.54	1.87	0.88	0.91	1.04	1.17
5.08 Media and Communication	0.80	0.89	1.08	1.65	1.28	1.21	1.03	0.73
5.09 Other Social Sciences	1.45	1.69	1.55	2.39	1.40	1.15	1.32	1.13
6 HUMANITIES	1.00	1.03	1.03	1.13	1.17	1.32	1.18	1.46
6.01 History and Archaeology	1.37	1.24	1.21	1.30	1.05	1.06	1.12	1.31
6.02 Languages and Literature	0.93	0.99	0.91	1.00	0.90	1.21	1.16	1.60
6.03 Philosophy, Ethics and Religion	1.09	1.14	1.15	0.98	1.54	1.62	1.18	1.54
6.04 Art	0.61	0.73	0.94	1.55	1.26	1.12	0.89	1.48
6.05 Other Humanities	0.48	0.48	0.60	0.78	1.25	1.64	1.19	1.44
Specialisation: Natural/Eng over HASS correlation	0.77	0.72	0.67	0.58	–0.17	–0.20	–0.20	–0.45
Growth of Relative Impact								1.22

Note: Years in the table are the end years of the five year period.

Numbers indicated in red are significantly below the world average for that period. Numbers indicated in green are significantly above the world average for that period.

Source: Thomson Reuters (2012) InCites™, report created 2 April 2014.

Appendix A. Supplementary data

Table A.1 Importance of competitiveness drivers, primary and manufacturing sectors, response means

Driver	A0	B0	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	AVE
Staff costs	5.80	5.74	5.67	6.55	5.57	6.00	5.77	5.81	5.50	5.90	5.76	5.63	5.48	6.13	5.92	5.88	5.58	5.81
Access to appropriate staff skills	5.54	5.84	5.79	6.17	5.23	6.07	5.93	5.29	5.71	5.90	5.77	5.56	5.96	5.98	6.19	5.91	5.60	5.79
Overall government policy	5.82	5.73	5.60	5.83	5.76	4.93	5.67	5.67	5.93	6.15	5.75	6.00	5.78	6.14	6.12	5.88	5.64	5.79
Level of technology employed	5.54	5.59	5.54	5.58	5.15	5.64	5.38	5.47	5.57	6.05	5.76	5.44	5.67	5.87	5.85	5.93	5.75	5.63
Quality of education & training institutions	5.57	5.73	5.42	6.08	5.39	5.07	5.90	4.71	5.64	6.00	5.76	5.44	5.57	5.98	5.96	5.81	5.45	5.62
Tax regime (overall)	5.68	5.48	5.67	5.58	5.63	5.79	5.55	5.11	5.50	5.85	5.81	5.44	5.27	5.91	5.58	5.91	5.67	5.61
Scientific and technical skills	5.47	5.43	5.71	5.73	4.74	4.21	5.87	5.27	5.21	6.19	5.86	5.67	5.73	5.76	5.96	5.85	5.59	5.54
Access to business relevant information	5.69	5.43	5.53	5.25	4.94	5.57	5.77	5.29	5.71	5.86	5.62	5.11	5.21	5.81	5.81	5.63	5.53	5.52
Quality of research institutions, organisations	5.69	5.47	5.39	5.42	5.32	4.79	5.91	4.75	5.57	6.00	5.67	5.44	5.17	5.67	5.85	5.92	5.31	5.49
Access to local managerial skills	5.25	5.37	5.52	5.92	4.88	5.46	5.80	5.24	5.36	5.67	5.55	5.22	5.54	5.44	5.96	5.70	5.35	5.48
Knowledge of Asian markets	5.48	5.52	5.33	5.75	5.09	5.07	5.33	5.44	5.71	6.24	5.30	4.67	5.65	5.53	5.80	5.65	5.45	5.47
Capabilities of companies from the country	5.26	5.25	5.54	5.42	4.97	5.43	5.46	5.44	5.57	5.95	5.71	5.22	5.21	5.40	5.60	5.86	5.52	5.46
Quality of life	5.62	5.38	5.19	5.75	5.13	5.23	5.82	5.13	5.64	5.35	5.45	5.67	5.17	5.72	5.77	5.57	5.27	5.46
Availability of equity capital	5.29	5.18	5.51	5.78	4.81	5.54	5.62	5.29	5.50	5.57	5.62	5.25	5.48	5.85	5.62	5.55	5.13	5.45
Policies to encourage R&D	5.67	5.33	5.39	4.92	5.41	4.79	5.64	5.06	5.36	6.10	5.52	5.33	5.04	5.59	5.88	5.69	5.39	5.42
Attitudes of community toward innovation	5.56	5.32	5.28	4.92	5.32	5.07	6.00	5.00	5.57	6.15	5.15	5.44	4.95	5.38	5.69	5.86	5.14	5.40
Communication infrastructure	5.08	5.27	5.50	5.33	4.79	5.20	5.27	5.35	5.50	5.71	5.64	5.00	5.31	5.84	5.38	5.55	5.39	5.36
IT and internet infrastructure	4.83	5.26	5.43	5.33	4.61	5.29	5.33	5.53	5.29	5.81	5.48	4.67	5.50	5.53	5.54	5.59	5.29	5.31
Attitudes toward entrepreneurship	5.46	5.10	5.29	4.83	5.41	4.80	5.80	4.88	5.57	5.95	4.90	5.11	4.74	5.48	5.23	5.61	5.20	5.26
Science and technology policy	5.42	5.25	5.14	4.50	5.14	4.64	5.82	5.13	5.21	5.79	5.26	5.22	4.87	5.30	5.50	5.67	5.11	5.23
Tough local competition	4.99	4.37	5.36	5.75	4.61	4.79	5.38	5.38	5.29	5.35	5.05	5.11	5.17	5.44	4.80	5.46	5.22	5.15
Access to debt finance	4.98	4.99	5.11	5.00	4.80	5.14	5.46	5.27	4.93	5.90	5.05	5.00	5.00	4.92	5.65	5.22	4.85	5.13
Availability of venture capital	5.17	5.05	5.25	5.20	4.84	5.38	4.77	5.35	4.93	5.43	5.48	3.88	4.92	5.46	5.35	5.45	4.94	5.11
Cooperation among local firms	5.21	4.75	4.97	5.10	5.29	5.14	5.15	5.18	5.36	5.60	4.90	4.56	4.87	4.90	5.32	5.31	5.07	5.10
Clustering of firms in your industry	4.73	4.76	4.84	5.10	5.16	4.71	5.25	5.31	5.36	5.29	5.10	4.33	4.65	4.93	5.08	5.25	4.74	4.98

Notes: 1= very unimportant / much worse than competitors / comparators, 4= neutral, 7= very important / much better than competitors / comparators.

A0 = Agriculture/ forestry/ fishing, B0 = Mining, C11 = Food Product Manufacturing, C12 = Beverage and Tobacco Product Manufacturing, C13 = Textile, Leather, Clothing and Footwear Manufacturing, C14 = Wood Product Manufacturing, C15 = Pulp, Paper and Converted Paper Product Manufacturing, C16 = Printing, C17 = Petroleum and Coal Product Manufacturing, C18 = Basic Chemical and Chemical Product Manufacturing, C19 = Polymer Product and Rubber Product Manufacturing, C20 = Non-Metallic Mineral Product Manufacturing, C21 = Primary Metal and Metal Product Manufacturing, C22 = Fabricated Metal Product Manufacturing, C23 = Transport Equipment Manufacturing, C24 = Machinery and Equipment Manufacturing, C25 = Furniture and Other Manufacturing. AVE = sector average.

Source: Michael J Enright and CPA Australia.

Table A.2 Australia's performance versus relevant competitiveness, primary and manufacturing sectors, response means

Driver	A0	B0	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	AVE
Quality of life	5.42	5.33	5.51	6.08	5.00	5.91	6.33	5.20	4.92	5.65	5.42	5.44	4.77	5.52	5.40	5.38	4.98	5.43
Quality of education & training institutions	5.19	4.90	5.11	5.00	4.67	5.69	6.13	5.27	4.77	5.10	5.60	4.78	5.05	5.07	4.92	5.14	4.65	5.12
Level of technology employed	5.08	5.02	4.71	5.27	5.00	5.54	5.64	5.07	4.92	4.86	5.20	4.67	4.91	5.22	4.65	5.22	4.74	5.04
Access to business relevant information	4.92	5.01	5.03	5.00	4.84	5.31	5.64	5.33	5.08	5.05	5.10	4.67	4.52	5.18	4.96	5.06	5.00	5.04
Quality of research institutions, organisations	5.11	4.82	5.07	5.00	4.73	5.38	6.00	4.86	4.46	5.25	5.37	4.78	4.64	5.14	4.88	5.21	4.35	5.00
Communication infrastructure	4.88	5.00	5.00	4.50	4.76	4.86	5.57	5.06	4.85	5.14	5.15	5.33	4.83	5.42	4.50	5.06	4.98	4.99
Scientific and technical skills	5.19	5.06	5.00	4.91	4.84	4.86	5.50	4.60	4.69	5.24	5.33	4.88	4.74	5.19	4.68	5.14	4.87	4.98
Access to local managerial skills	5.07	5.02	5.02	4.50	4.88	4.86	5.36	5.07	5.23	4.90	5.00	4.89	4.57	5.08	4.76	5.26	4.91	4.96
Access to debt finance	4.92	4.79	4.86	4.91	4.65	4.93	5.62	4.86	5.00	5.00	5.20	5.00	4.62	4.96	4.68	5.20	4.77	4.94
Access to appropriate staff skills	4.86	4.92	5.00	4.50	5.03	4.86	5.21	5.13	5.00	4.95	4.79	4.44	4.78	5.13	4.40	5.10	4.83	4.88
Capabilities of companies from the country	4.93	4.90	4.92	4.90	4.54	5.33	4.80	4.80	5.08	5.35	4.95	4.78	4.74	4.76	4.72	4.94	4.43	4.87
IT and internet infrastructure	4.76	4.89	4.69	4.25	4.62	4.86	5.64	5.06	4.46	5.14	4.89	5.00	4.57	5.19	4.46	5.03	4.67	4.83
Attitudes of community toward innovation	4.83	4.22	5.04	4.18	4.58	4.38	5.78	4.63	4.31	5.15	5.00	5.44	4.10	5.12	4.58	4.95	4.49	4.75
Science and technology policy	4.63	4.61	4.72	4.09	4.64	5.15	5.00	4.87	4.85	4.85	4.65	4.56	4.59	4.33	4.80	4.59	4.38	4.67
Knowledge of Asian markets	4.95	4.78	4.63	5.25	3.77	4.69	5.08	4.53	4.54	4.86	4.05	5.33	4.41	4.28	4.56	4.91	4.57	4.66
Availability of equity capital	4.52	4.46	4.81	4.45	4.23	4.92	5.71	4.53	5.00	4.29	4.79	4.25	4.59	4.49	4.40	4.88	4.64	4.64
Availability of venture capital	4.43	4.43	4.72	4.73	4.17	4.92	5.43	4.40	4.69	4.29	4.63	5.00	4.36	4.42	4.25	4.71	4.66	4.60
Attitudes toward entrepreneurship	4.69	4.21	4.78	3.58	4.62	4.54	5.25	4.63	4.23	4.70	4.89	5.22	4.05	4.98	4.62	4.92	4.35	4.60
Co-operation among local firms	4.67	4.44	4.56	4.56	4.59	5.46	5.09	4.33	5.08	4.65	4.58	4.11	4.38	4.10	4.28	4.76	4.25	4.58
Policies to encourage R&D	4.60	4.52	4.86	4.27	4.64	4.54	5.11	4.67	4.62	4.75	4.72	4.44	4.27	4.23	4.62	4.51	4.36	4.57
Tough local competition	4.77	4.43	4.79	4.70	4.46	4.85	5.00	4.60	4.62	4.75	4.50	4.00	4.35	4.19	4.29	4.92	4.34	4.56
Clustering of firms in your industry	4.58	4.55	4.30	4.60	3.97	4.46	4.69	4.06	4.85	4.71	4.67	4.22	4.32	4.35	4.24	4.46	4.31	4.43
Overall government policy	4.24	3.92	4.50	3.82	4.45	4.08	5.09	4.06	4.85	4.42	4.05	4.44	4.09	3.66	4.08	4.61	4.40	4.28
Tax regime (overall)	4.43	3.70	4.37	4.18	4.24	4.18	4.40	3.81	4.08	4.50	4.58	4.33	4.33	3.60	4.23	4.63	4.30	4.23
Staff costs	3.71	3.75	4.14	3.45	3.90	3.92	5.07	3.82	4.54	3.90	3.47	3.78	3.74	3.64	3.58	4.34	3.96	3.92

Notes: 1= very unimportant / much worse than competitors / comparators, 4= neutral, 7= very important / much better than competitors / comparators.

A0 = Agriculture/ forestry/ fishing, B0 = Mining, C11 = Food Product Manufacturing, C12 = Beverage and Tobacco Product Manufacturing, C13 = Textile, Leather, Clothing and Footwear Manufacturing, C14 = Wood Product Manufacturing, C15 = Pulp, Paper and Converted Paper Product Manufacturing, C16 = Printing, C17 = Petroleum and Coal Product Manufacturing, C18 = Basic Chemical and Chemical Product Manufacturing, C19 = Polymer Product and Rubber Product Manufacturing, C20 = Non-Metallic Mineral Product Manufacturing, C21 = Primary Metal and Metal Product Manufacturing, C22 = Fabricated Metal Product Manufacturing, C23 = Transport Equipment Manufacturing, C24 = Machinery and Equipment Manufacturing, C25 = Furniture and Other Manufacturing. AVE = sector average. AVE = sector average.

Source: Michael J Enright and CPA Australia.

Table A.3 Importance of competitiveness drivers, utilities, construction, and service sectors, response means

Driver	D0 & E0	F0	G0	H0	I0	J0	K0	L0	M0	N0	O0	P0	Q0	R0	S0	AVE
Access to appropriate staff skills	5.86	5.59	5.52	5.62	5.77	5.80	5.86	5.26	5.99	5.79	5.99	6.12	6.08	5.33	5.50	5.74
IT and internet infrastructure	5.41	5.60	5.61	5.35	5.73	6.16	6.01	5.57	5.97	5.94	5.81	5.83	5.55	5.42	5.43	5.69
Staff costs	5.71	5.82	5.92	5.88	5.81	5.68	5.74	5.42	5.83	5.48	5.61	5.84	5.80	5.28	5.42	5.68
Communication infrastructure	5.56	5.63	5.48	5.31	5.77	6.00	5.90	5.48	5.87	5.85	5.75	5.76	5.64	5.19	5.43	5.64
Quality of life	5.62	5.49	5.65	5.77	5.62	5.43	5.63	5.85	5.55	5.35	5.30	5.91	5.96	5.87	5.42	5.63
Quality of education & training institutions	5.68	5.48	5.38	5.54	5.58	5.59	5.69	5.55	5.87	5.43	5.38	6.29	6.15	5.42	5.37	5.63
Level of technology employed	5.66	5.52	5.55	5.41	5.65	5.84	5.80	5.43	5.73	5.64	5.68	5.72	5.64	5.06	5.35	5.58
Overall government policy	5.75	5.65	5.50	5.52	5.68	5.30	5.83	5.81	5.50	5.52	5.83	5.78	5.79	4.85	5.30	5.57
Access to business relevant information	5.59	5.61	5.58	5.58	5.65	5.53	5.80	5.72	5.61	5.61	5.21	5.33	5.43	5.18	5.19	5.51
Tax regime (overall)	5.78	5.70	5.57	5.55	5.74	5.38	5.65	5.89	5.60	5.39	4.89	5.21	5.44	5.09	5.26	5.48
Access to local managerial skills	5.42	5.39	5.32	5.36	5.49	5.43	5.55	5.19	5.50	5.40	5.53	5.48	5.50	4.88	5.10	5.37
Quality of research institutions, organisations	5.42	5.32	5.16	4.92	5.32	5.38	5.39	4.99	5.53	5.18	5.19	5.87	6.06	4.74	5.11	5.31
Attitudes of community toward innovation	5.37	5.35	5.50	5.34	5.43	5.35	5.32	5.39	5.34	5.06	4.85	5.54	5.33	5.10	5.15	5.29
Capabilities of companies from the country	5.38	5.30	5.36	5.31	5.44	5.34	5.50	5.25	5.36	5.15	4.78	5.28	5.10	5.00	5.02	5.24
Attitudes toward entrepreneurship	5.27	5.17	5.44	5.29	5.33	5.20	5.30	5.46	5.19	5.03	4.62	5.33	5.12	5.23	5.10	5.21
Scientific and technical skills	5.41	5.24	4.78	4.49	5.13	5.66	4.91	4.44	5.54	5.09	5.45	5.41	5.69	4.73	4.86	5.12
Tough local competition	5.21	5.40	5.43	5.54	5.29	4.97	5.22	5.59	4.99	5.07	3.74	5.21	4.70	4.74	4.90	5.07
Geographic location	5.03	5.09	5.09	5.80	5.41	4.76	4.84	5.41	4.91	4.82	4.69	5.08	5.02	4.75	4.74	5.03
Availability of equity capital	5.45	5.24	5.31	5.38	5.32	4.95	5.44	5.70	4.86	4.90	4.21	4.52	4.94	4.29	4.71	5.01
Co-operation among local firms	5.19	5.03	5.04	5.34	5.21	4.85	4.82	4.91	4.94	4.93	4.50	5.15	4.90	4.79	4.83	4.96
Policies to encourage R&D	5.13	5.03	4.89	4.65	4.95	5.16	4.67	4.51	5.15	4.72	5.00	5.26	5.47	4.34	4.63	4.90
Availability of venture capital	5.26	4.99	5.21	5.21	5.15	5.00	5.01	5.33	4.72	4.84	3.99	4.49	4.74	4.44	4.62	4.87
Knowledge of Asian markets	4.92	5.39	5.14	4.92	5.15	5.12	5.28	4.60	4.93	4.48	4.16	4.81	3.98	4.10	4.42	4.76
Science and technology policy	5.04	4.97	4.84	4.61	4.84	5.24	4.58	4.32	5.00	4.59	4.78	5.01	5.16	3.96	4.44	4.76
Access to debt finance	5.25	4.91	4.81	4.67	5.13	4.68	5.33	5.32	4.68	4.56	4.06	4.28	4.29	3.94	4.52	4.70
Clustering of firms in your industry	4.78	4.70	4.77	4.58	4.85	4.78	4.90	4.38	4.57	4.46	4.11	4.64	4.50	4.24	4.37	4.58

Notes: 1= very unimportant / much worse than competitors / comparators, 4= neutral, 7= very important / much better than competitors / comparators.

D0&E0 = Utilities and construction, F0 = Wholesale trade, G0 = Retail Trade, H0 = Accommodation and Food Services, I0 = Transport, Postal, Warehousing, J0 = Information, Media, Telecommunications, K0 = Finance and Insurance Services, L0 = Rental, Hiring, Real Estate Services, M0 = Professional, Scientific and Technical Services, N0 = Administrative and Support Services, O0 = Public Administration and Safety, P0 = Education and Training, Q0 = Health Care and Social Assistance, R0 = Arts and Recreation, S0 = Other Services. AVE = sector average.

Source: Michael J Enright and CPA Australia.

Table A.4 Australia's performance versus relevant competitiveness, utilities, construction, and service sectors, response means

Driver	D0 & E0	F0	G0	H0	I0	J0	K0	L0	M0	N0	O0	P0	Q0	R0	S0	AVE
Quality of life	5.30	5.47	5.34	5.32	5.20	5.33	5.52	5.47	5.35	5.36	5.20	5.58	5.32	5.16	5.22	5.34
Access to local managerial skills	5.03	5.22	4.99	4.92	4.88	4.89	4.99	4.90	4.84	5.04	4.69	4.93	4.94	4.61	4.89	4.92
Quality of education & training institutions	4.99	5.07	4.82	4.82	4.81	4.84	5.08	5.09	4.96	5.03	4.88	5.01	5.03	4.61	4.82	4.92
Access to appropriate staff skills	4.91	5.23	4.94	4.83	4.92	4.85	5.04	4.71	4.77	5.03	4.74	4.97	5.00	4.74	4.87	4.90
Scientific and technical skills	4.97	5.08	4.75	4.92	4.75	4.83	4.87	4.80	4.84	5.03	4.69	4.87	5.01	4.75	4.72	4.86
Quality of research institutions, organisations	4.89	4.94	4.85	4.79	4.77	4.81	4.92	4.95	4.86	4.97	4.88	4.90	4.91	4.71	4.76	4.86
Access to debt finance	5.04	5.09	4.78	5.02	4.96	4.84	5.04	4.76	4.67	4.86	4.84	4.83	4.79	4.55	4.75	4.85
Access to business relevant information	4.97	4.92	4.91	4.88	4.80	4.83	5.05	4.70	4.83	5.04	4.77	4.90	4.86	4.53	4.79	4.85
Level of technology employed	4.93	4.93	4.85	4.80	4.78	4.83	4.84	4.73	4.86	4.91	4.56	4.82	4.88	4.64	4.82	4.81
Communication infrastructure	4.91	5.21	4.86	4.99	4.80	4.61	4.92	4.54	4.76	4.87	4.47	4.69	4.89	4.52	4.81	4.79
IT and internet infrastructure	4.79	5.16	4.81	4.84	4.73	4.56	4.86	4.27	4.71	4.80	4.46	4.67	4.72	4.43	4.74	4.70
Capabilities of companies from the country	4.83	4.80	4.62	4.65	4.66	4.66	4.80	4.58	4.69	4.86	4.71	4.67	4.62	4.43	4.67	4.68
Attitudes of community toward innovation	4.81	4.64	4.71	4.83	4.69	4.67	4.73	4.68	4.49	4.82	4.75	4.77	4.67	4.30	4.68	4.68
Tough local competition	4.59	4.55	4.61	4.87	4.60	4.56	4.84	4.94	4.51	4.90	4.63	4.71	4.64	4.41	4.73	4.67
Availability of equity capital	4.77	4.63	4.60	4.78	4.75	4.54	4.64	4.76	4.50	4.78	4.63	4.62	4.72	4.41	4.65	4.65
Attitudes toward entrepreneurship	4.70	4.71	4.66	4.82	4.46	4.70	4.67	4.72	4.46	4.84	4.63	4.69	4.67	4.31	4.57	4.64
Knowledge of Asian markets	4.59	4.64	4.54	4.56	4.73	4.73	4.67	4.59	4.57	4.54	4.67	4.72	4.60	4.59	4.58	4.62
Co-operation among local firms	4.59	4.47	4.43	4.70	4.48	4.46	4.69	4.55	4.35	4.81	4.67	4.58	4.58	4.16	4.61	4.54
Availability of venture capital	4.66	4.58	4.49	4.68	4.53	4.44	4.54	4.59	4.29	4.71	4.49	4.51	4.67	4.32	4.57	4.54
Science and technology policy	4.63	4.60	4.52	4.63	4.51	4.49	4.47	4.38	4.39	4.79	4.48	4.55	4.54	4.42	4.44	4.52
Clustering of firms in your industry	4.51	4.40	4.42	4.40	4.48	4.42	4.56	4.28	4.31	4.64	4.39	4.58	4.56	4.20	4.38	4.44
Policies to encourage R&D	4.54	4.45	4.44	4.45	4.36	4.44	4.39	4.40	4.27	4.70	4.48	4.50	4.47	4.24	4.42	4.44
Overall government policy	4.34	4.14	4.09	4.33	4.15	4.56	4.53	4.19	4.33	4.80	4.89	4.65	4.61	3.94	4.31	4.39
Tax regime (overall)	4.20	3.99	4.19	4.49	4.00	4.37	4.17	4.32	4.05	4.58	4.66	4.30	4.24	4.00	4.15	4.25
Staff costs	4.24	3.79	4.02	3.99	4.05	4.13	4.35	4.01	4.03	4.33	4.26	4.28	4.30	4.30	4.35	4.16

Notes: 1= very unimportant / much worse than competitors / comparators, 4= neutral, 7= very important / much better than competitors / comparators.

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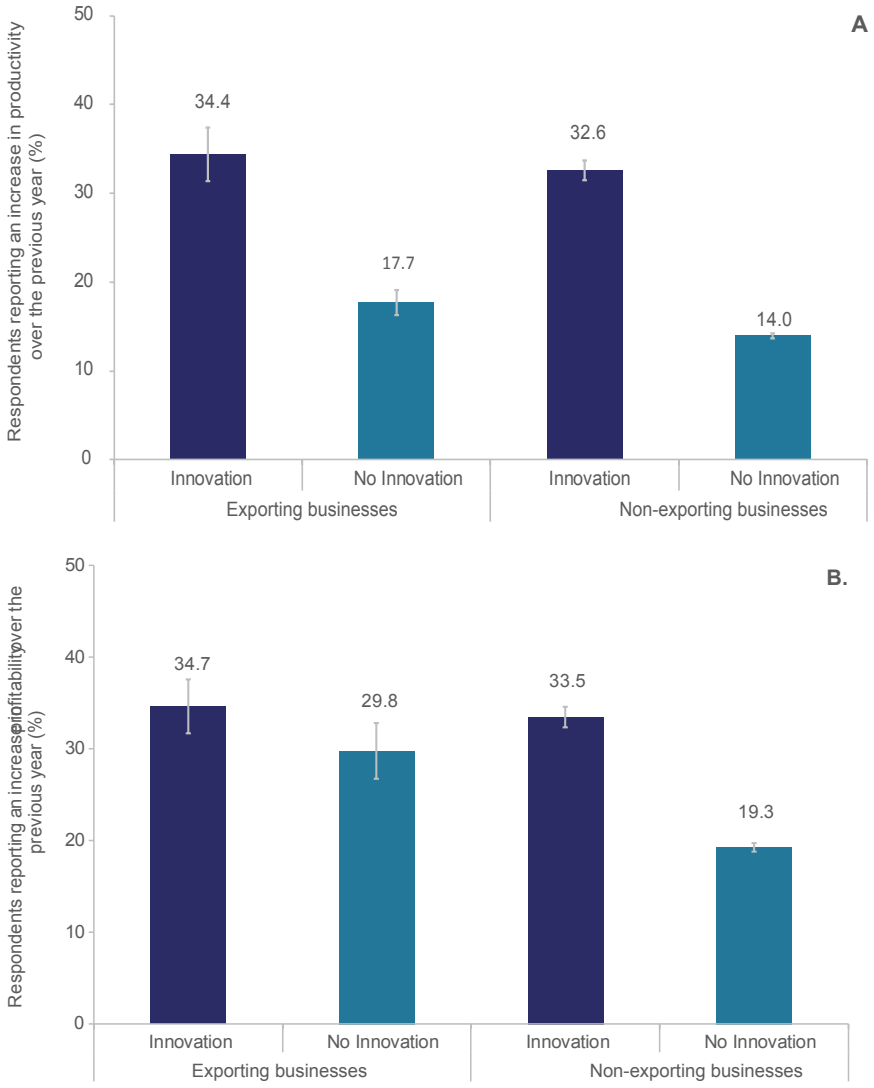
Source: Michael J Enright and CPA Australia.

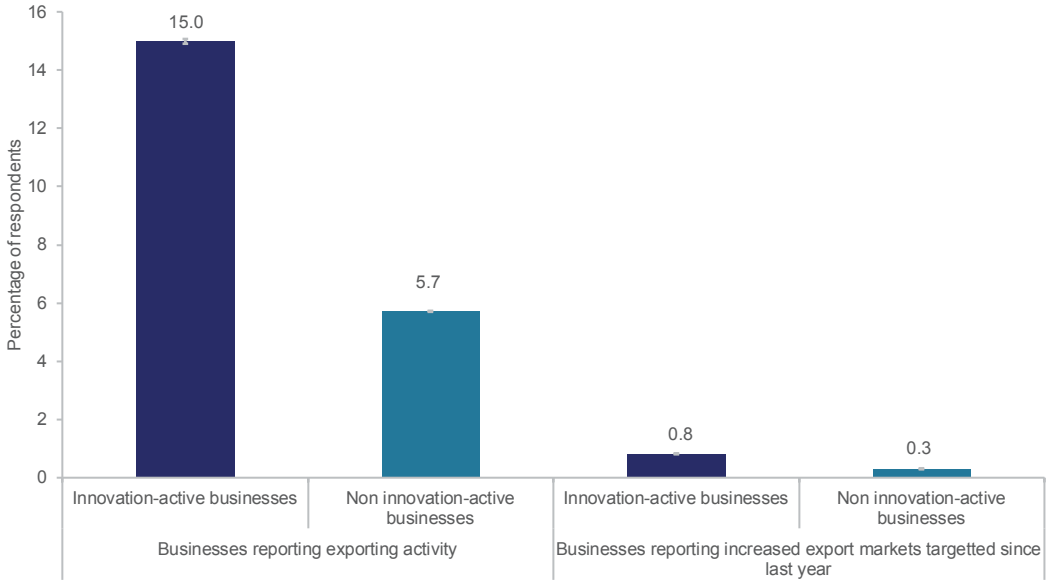
A.2 Chapter 2

Figure A.1 The impact of innovation and exporting on the likelihood of business productivity (A) and profitability (B) growth, 2011–12



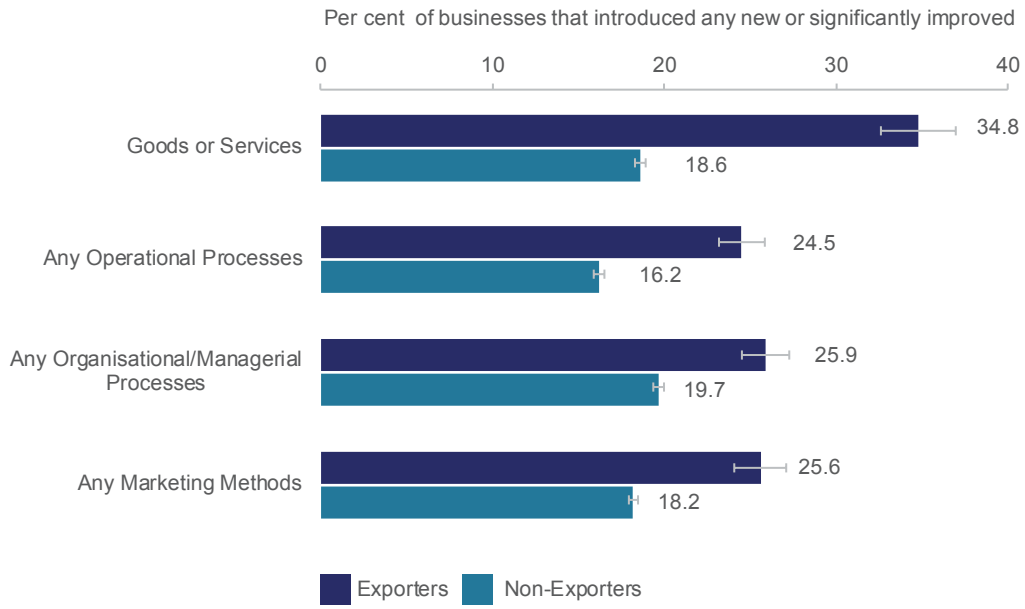
Source: ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

Figure A.2 Proportion of businesses that are exporting and the proportion of businesses reporting annual growth in the number of export markets being targeted, 2012–13



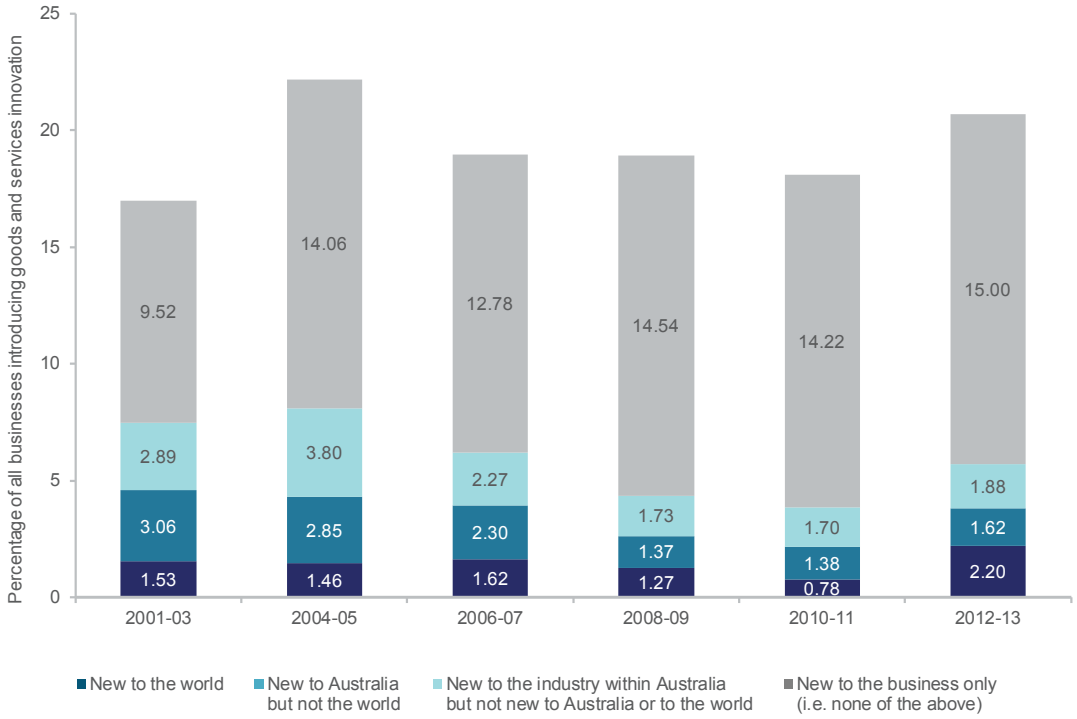
Source: ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

Figure A.3 Type of innovation by export status, 2012–13



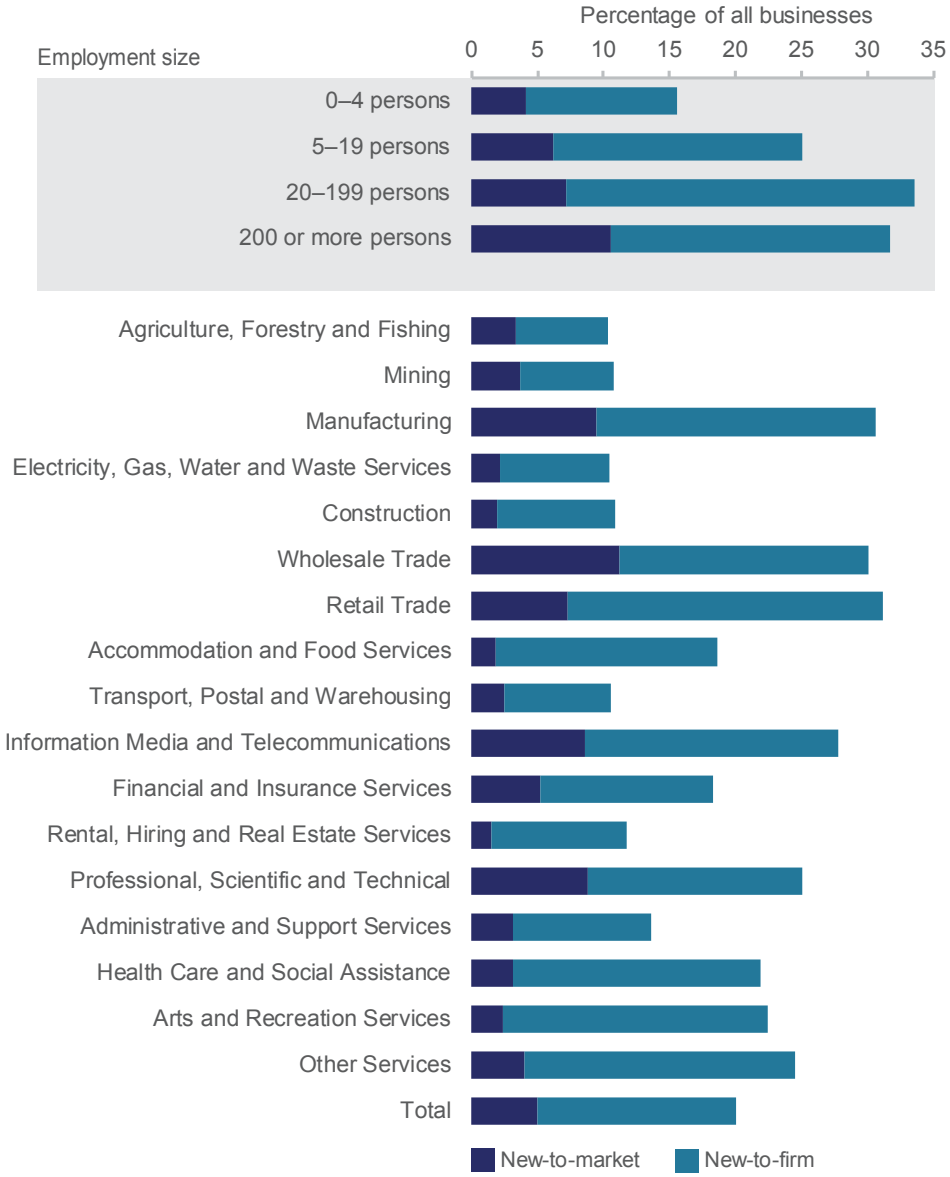
Source: ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

Figure A.4 Degree of innovation novelty in Australian goods and services innovation, 2001–03 to 2012–13



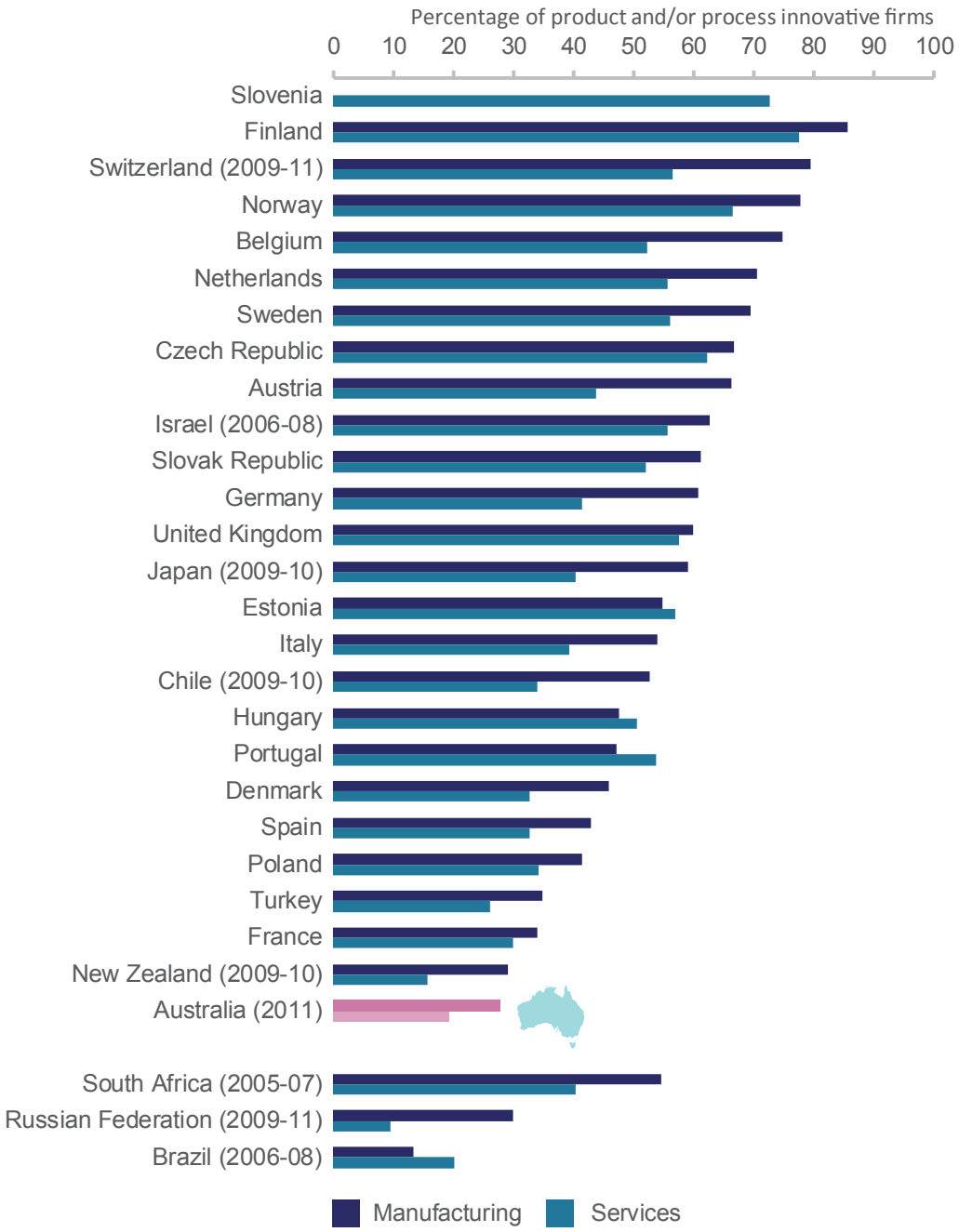
Source: ABS (various) Innovation in Australian business, cat. no. 8158.0, ABS, Canberra.

Figure A.5 Degree of goods and services innovation novelty, by business size and industry, 2012–13



Source: ABS (2014) Innovation in Australian business, cat. no. 8158.0, ABS, Canberra.

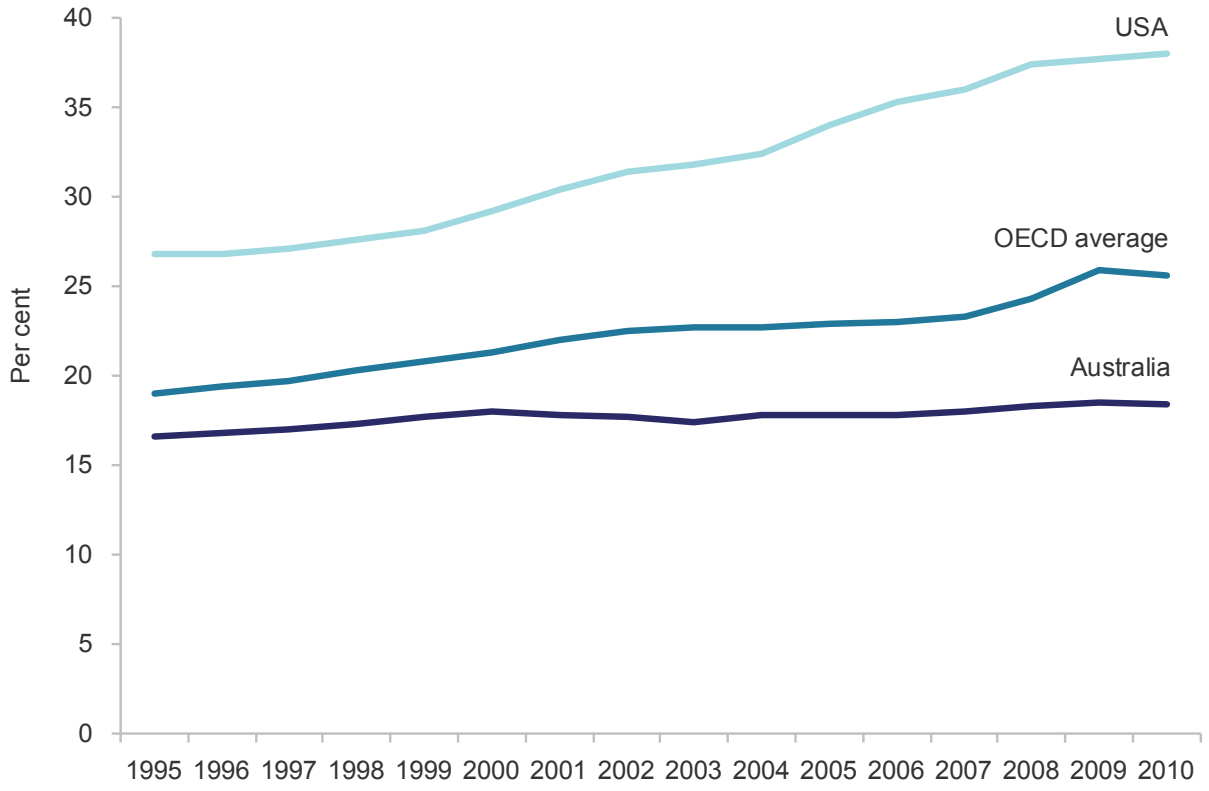
Figure A.6 R&D-active innovating firms, by sector, 2008–10



Notes: For Australia, data refer to financial year 2010–11 and include product, process, marketing and organisational innovative firms (including ongoing or abandoned innovation activities). See source for additional country notes.

Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013.

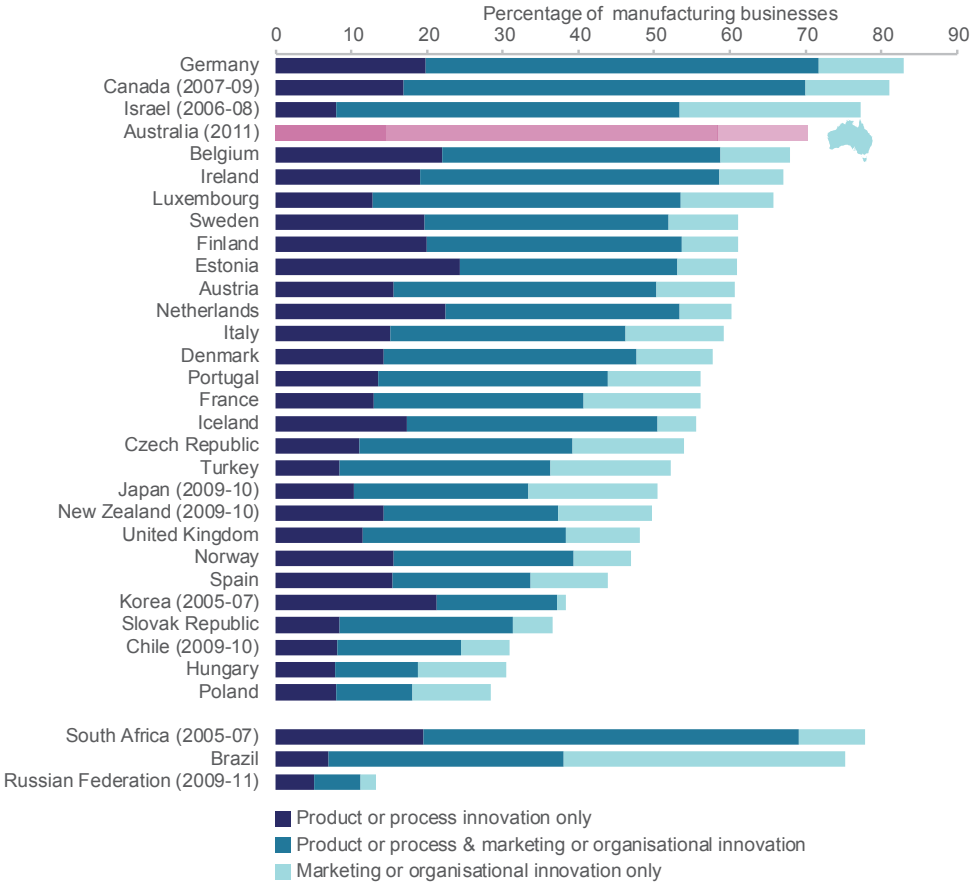
Figure A.7 Intangible capital stock accumulation by country, 1995–2010



Notes: Fixed capital stock value measures current replacement cost. OECD figures are for 15 OECD countries where data were available.

Source: INTAN-Invest Database, www.intan-invest.net, and Melbourne Institute of Applied Economic and Social Research (2012). Figures commissioned by the Australian Government Department of Industry.

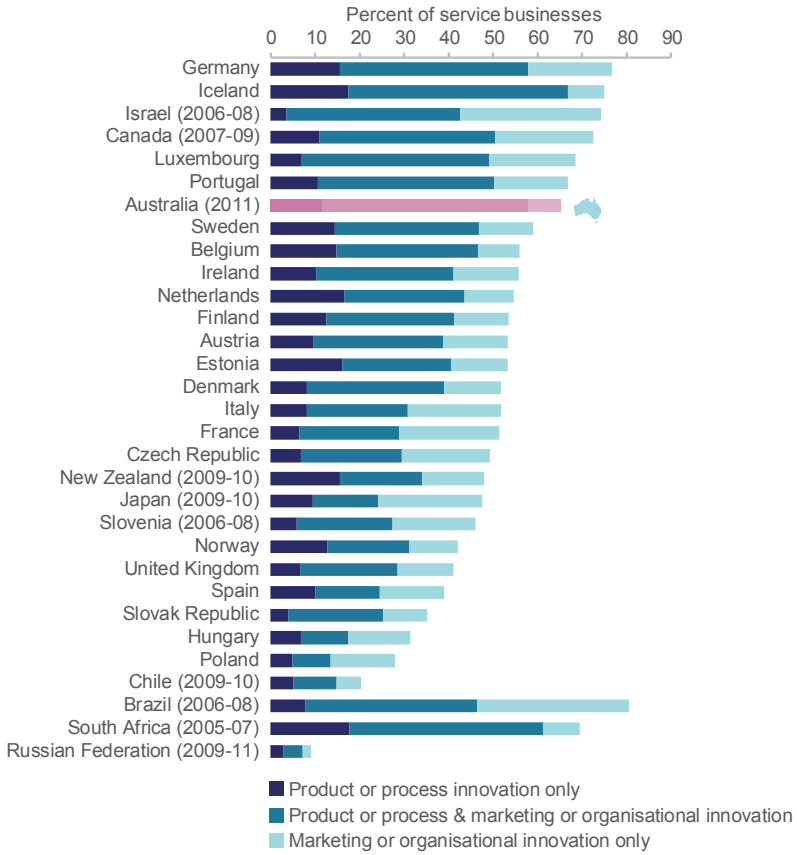
Figure A.8 Innovation in the manufacturing sector, 2008–10



Notes: For Australia, data refer to financial year 2010–11 and include product, process, marketing and organisational innovative firms (including ongoing or abandoned innovation activities). See source for additional country notes.

Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013.

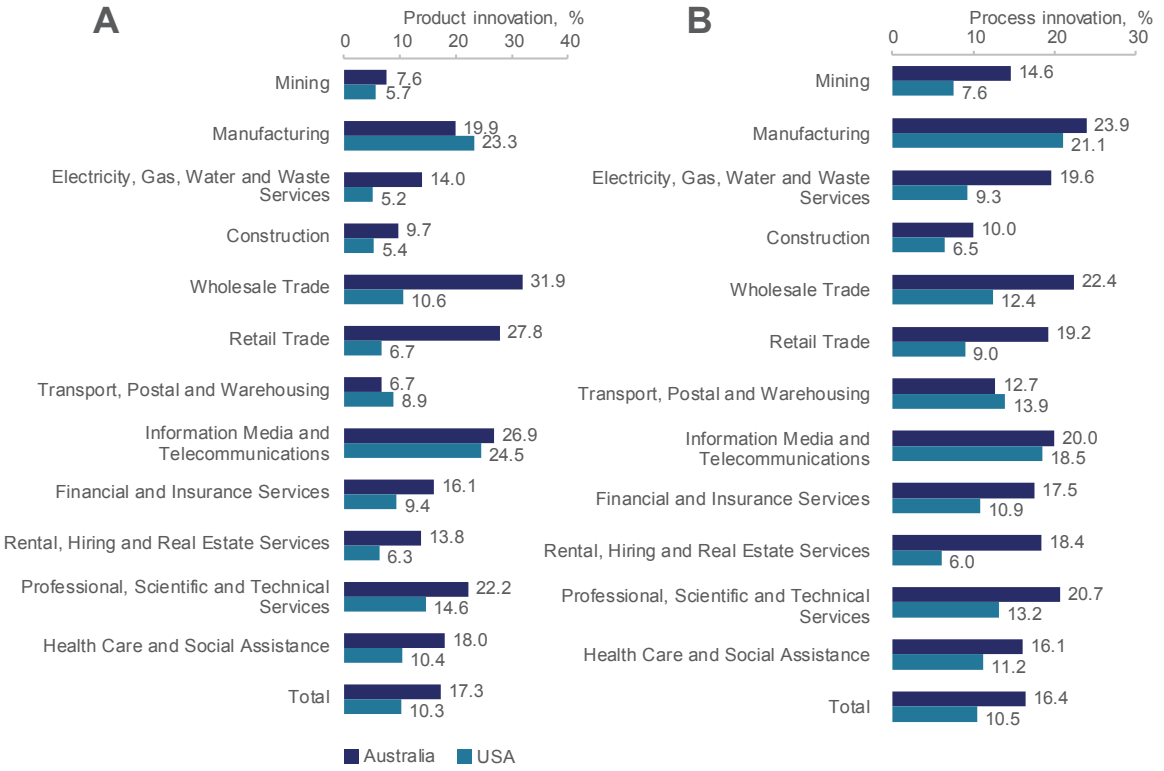
Figure A.9 Innovation in the service sector, 2008–10



Notes: For Australia, data refer to financial year 2010–11 and include product, process, marketing and organisational innovative firms (including ongoing or abandoned innovation activities). See source for additional country notes.

Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013.

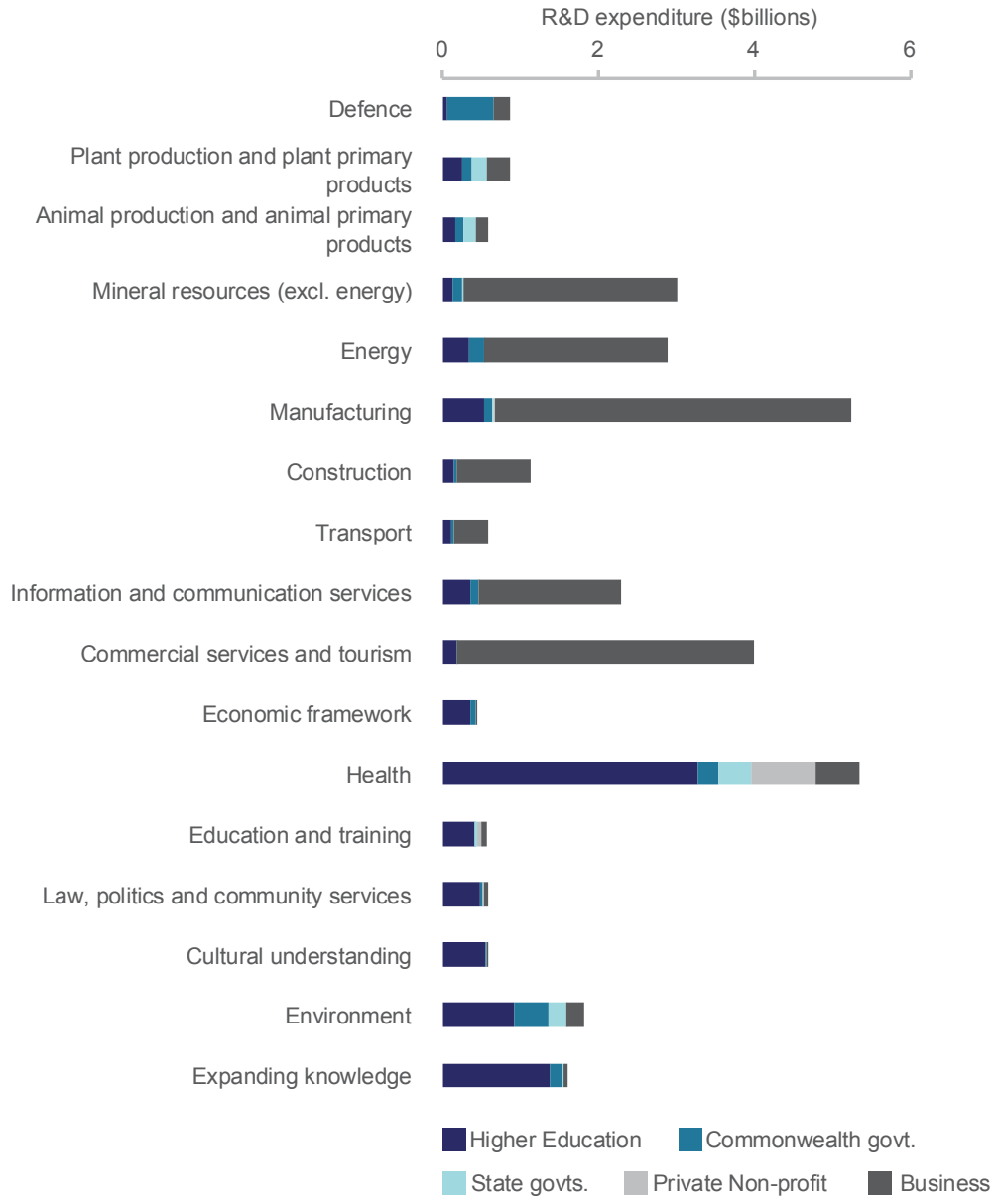
Figure A.10 Australian and US business product, goods and services (A) and process (B) innovation, by sector, 2010



Notes: This comparison is indicative only as there are some variations between industry classifications. The US uses the 2007 North American Industry Classification System and Australia uses the 2006 Australia New Zealand Industry Classification System.

Sources: National Science Foundation/National Center for Science and Engineering Statistics and US Census Bureau (2010) Business R&D and Innovation Survey; ABS (2012) Innovation in Australian business, 2010–11, cat. no. 8158.0, Canberra.

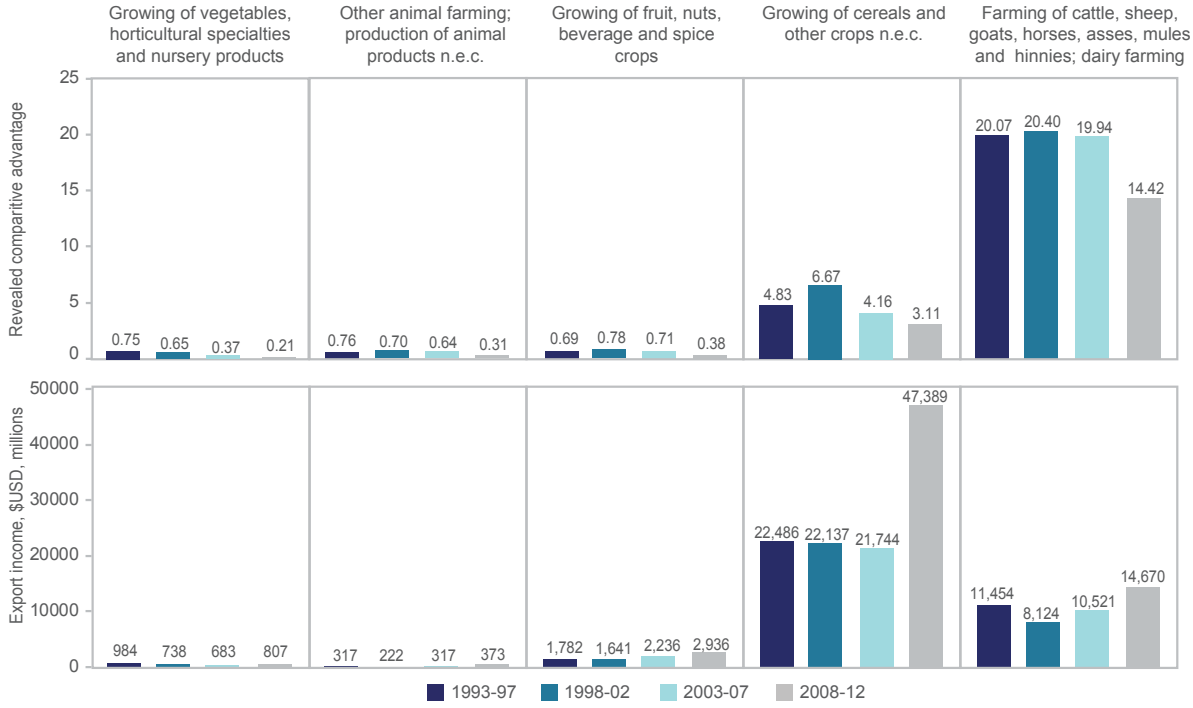
Figure A.11 R&D expenditure, by sector, by socioeconomic objective, 2011–12



Sources: ABS (2014) Research and Experimental Development, Higher Education Organisations, Australia, 2012, cat. No. 8111.0; ABS (2013) Research and Experimental Development, Government and Private Non-Profit Organisations, Australia, 2011–12, cat. No. 8109.0; ABS (2013) Research and Experimental Development, Businesses, Australia, 2011–12, cat. No. 8104.0

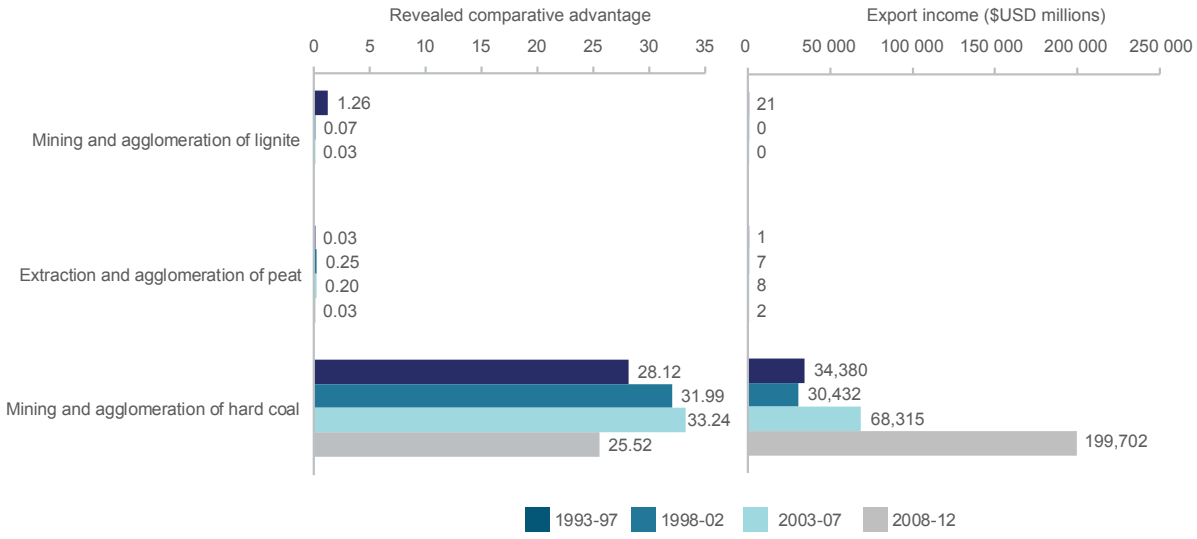
A.3 Chapter 3

Figure A.12 Revealed comparative advantage (A) and export value (B) of the agriculture sector, 1993–97 to 2008–12



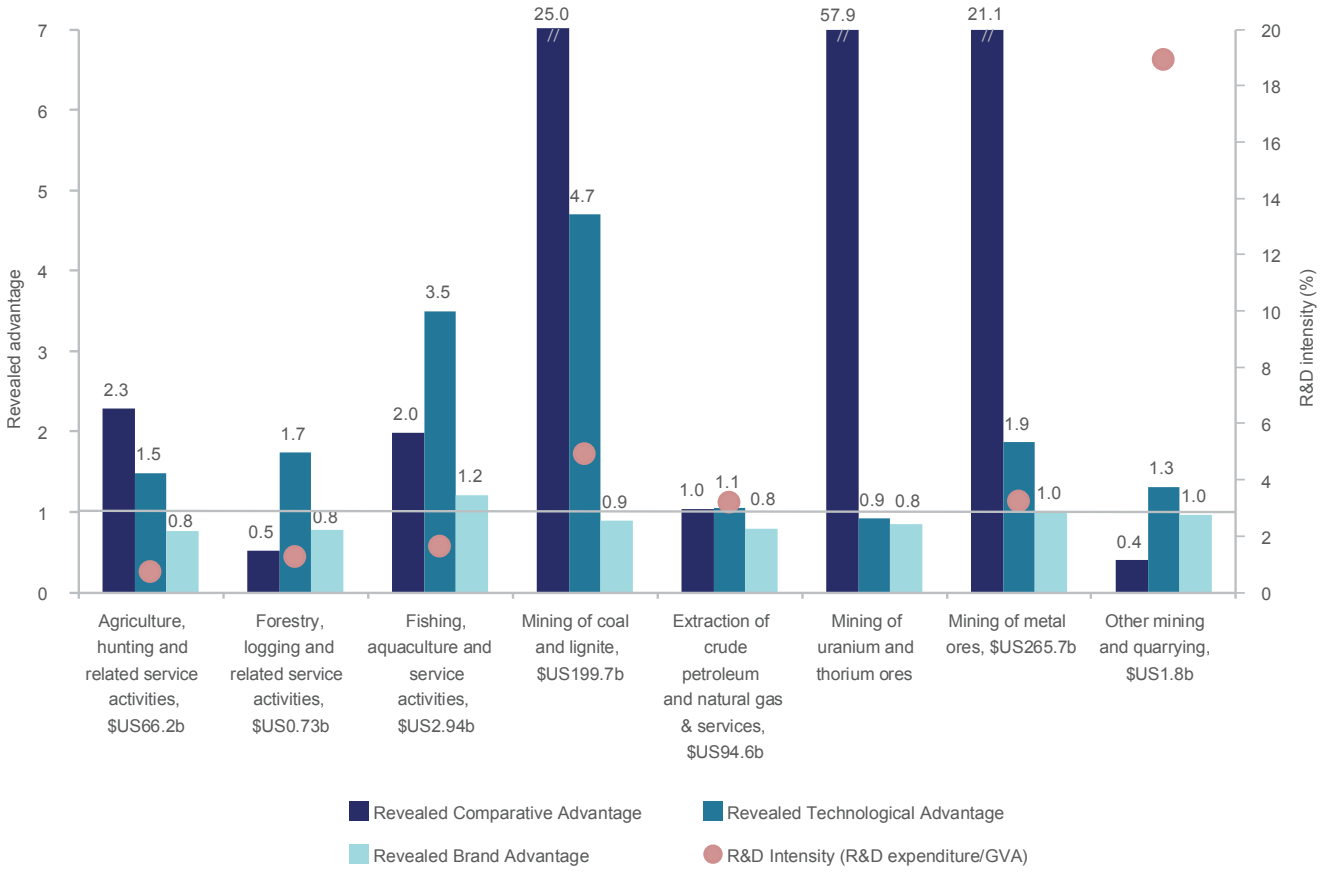
Source: UNCTAD COMTRADE database.

Figure A.13 Revealed comparative advantage (A) and export values (B) of the mining of coal and lignite, extraction of peat sector, 1993–97 to 2008–12



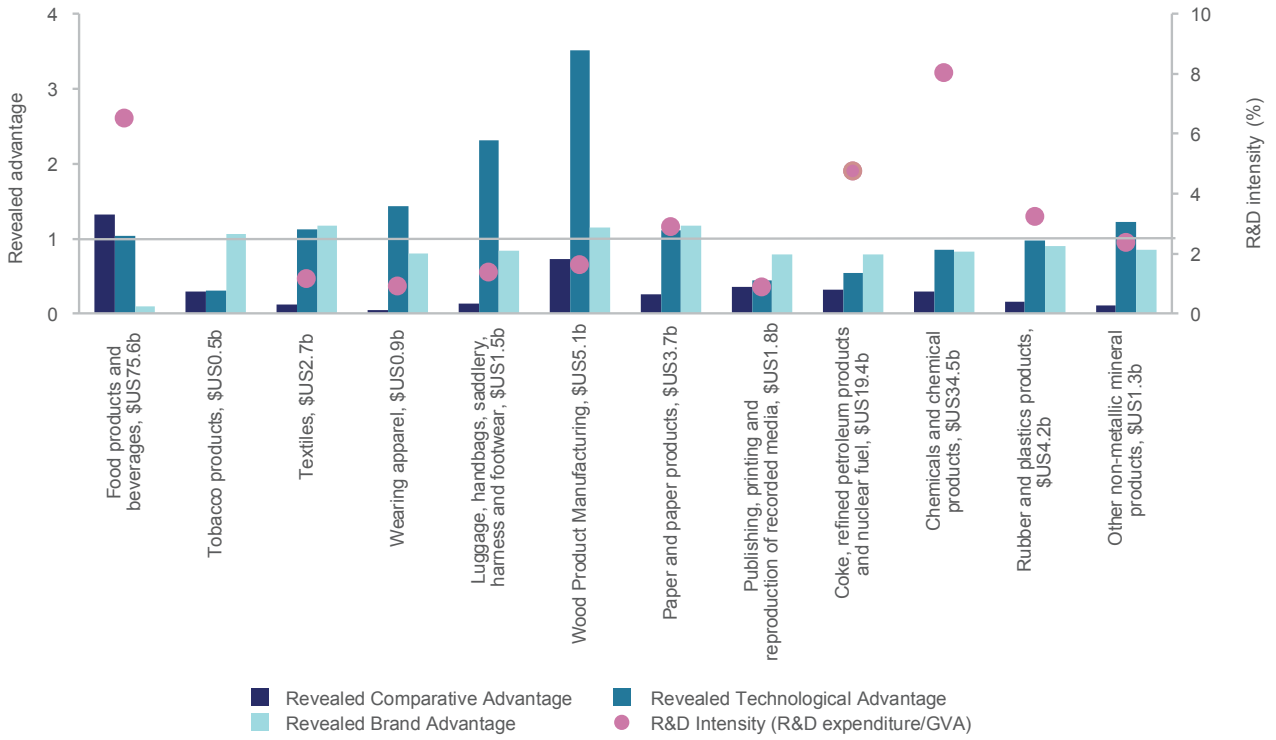
Source: UNCTAD COMTRADE database.

Figure A.14 Australia's revealed advantage, for exports (RCA), patents (RTA), trademarks (RBA) and R&D intensity, for natural resource commodities, 2008–12



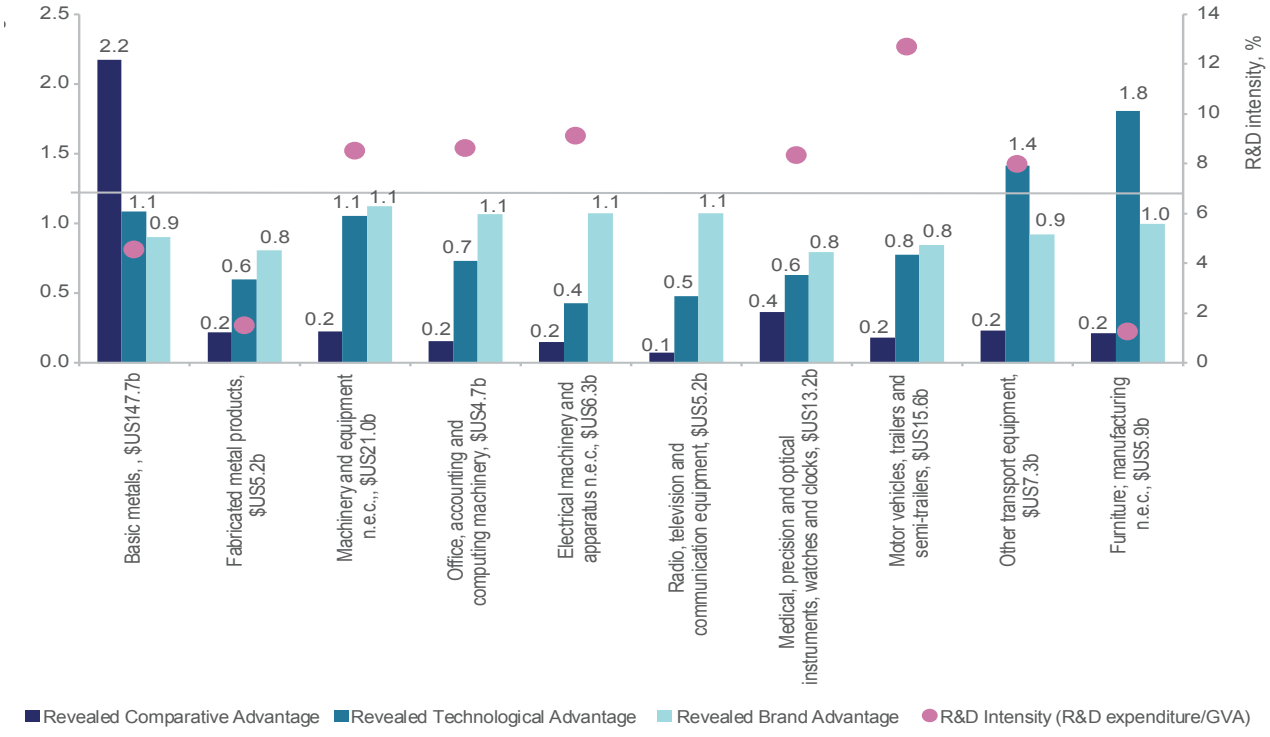
Source: UNCTAD COMTRADE database; IP Australia special request.

Figure A.15 Australia's revealed advantage, for exports (RCA), patents (RTA), trademarks (RBA) and R&D intensity, for manufactured food, textiles, chemicals and other selected products, 2008–12



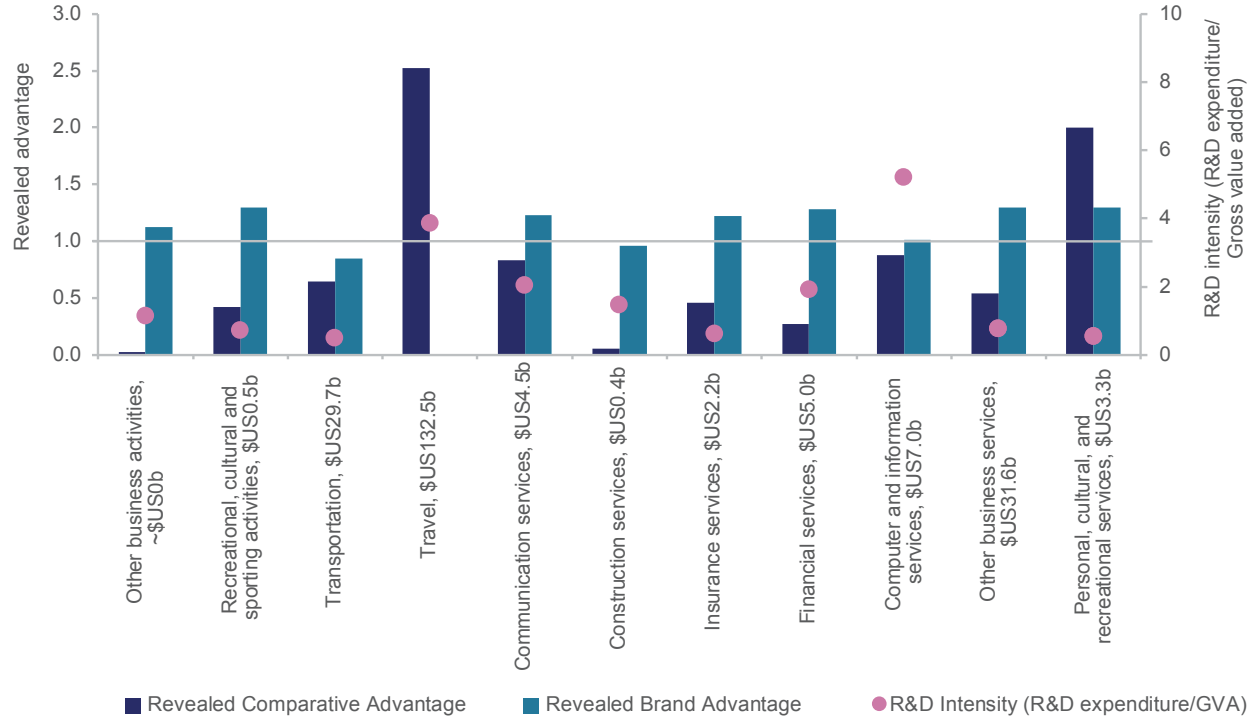
Source: UNCTAD COMTRADE database; IP Australia special request.

Figure A.16 Australia's revealed advantage, for exports (RCA), patents (RTA), trademarks (RBA) and R&D intensity, for metals and elaborately transformed goods, 2008–12



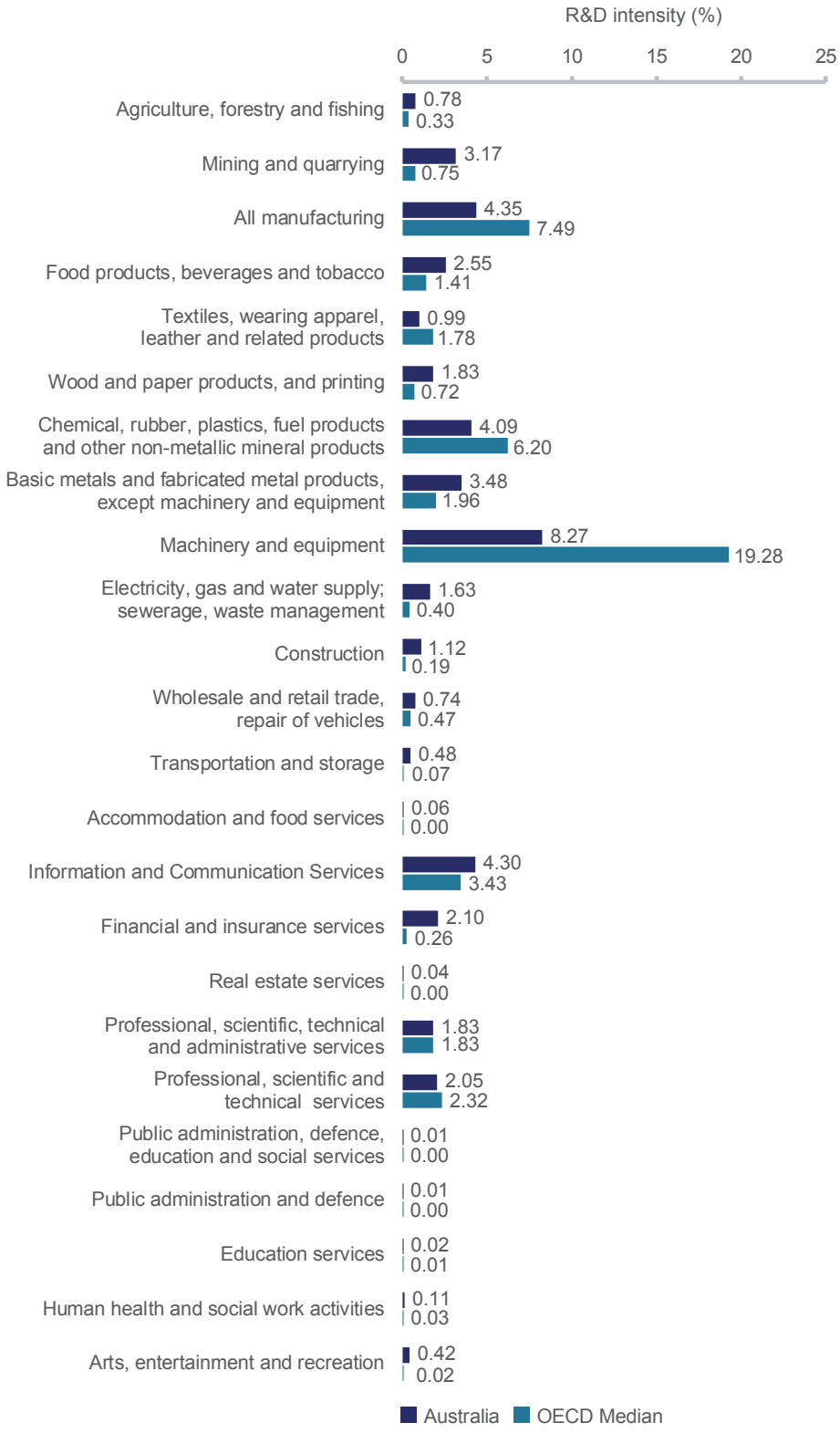
Source: UNCTAD COMTRADE database; IP Australia special request.

Figure A.17 Australia's revealed advantage, for exports (RCA), trademarks (RBA) and R&D intensity, for selected services, 2007–11



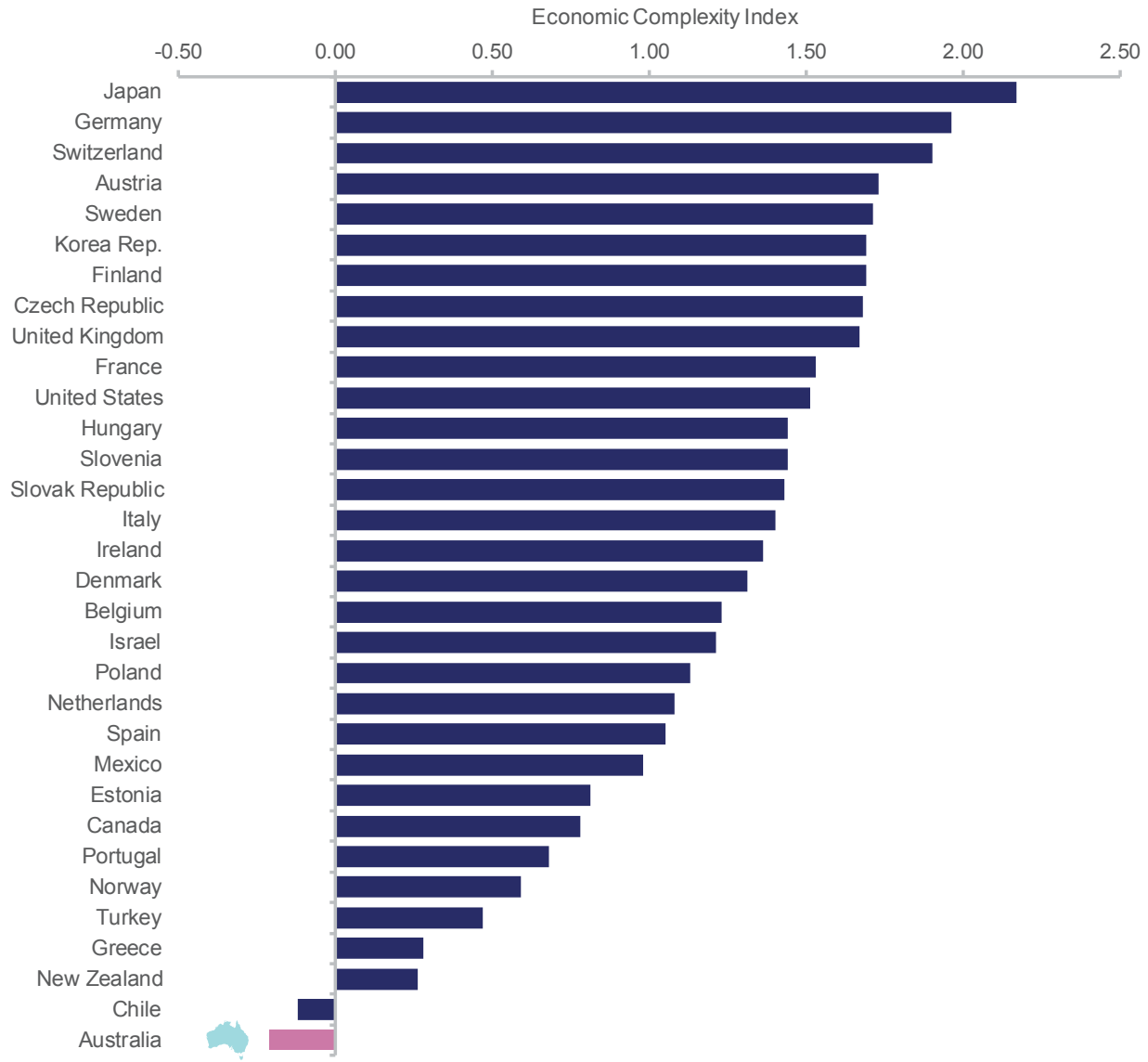
Source: UNCTAD COMTRADE database; IP Australia special request.

Figure A.18 Business R&D intensity, by sector; Australia vs OECD median, 2010



Source: OECD STAN Database for Structural Analysis (ISIC Rev. 4).

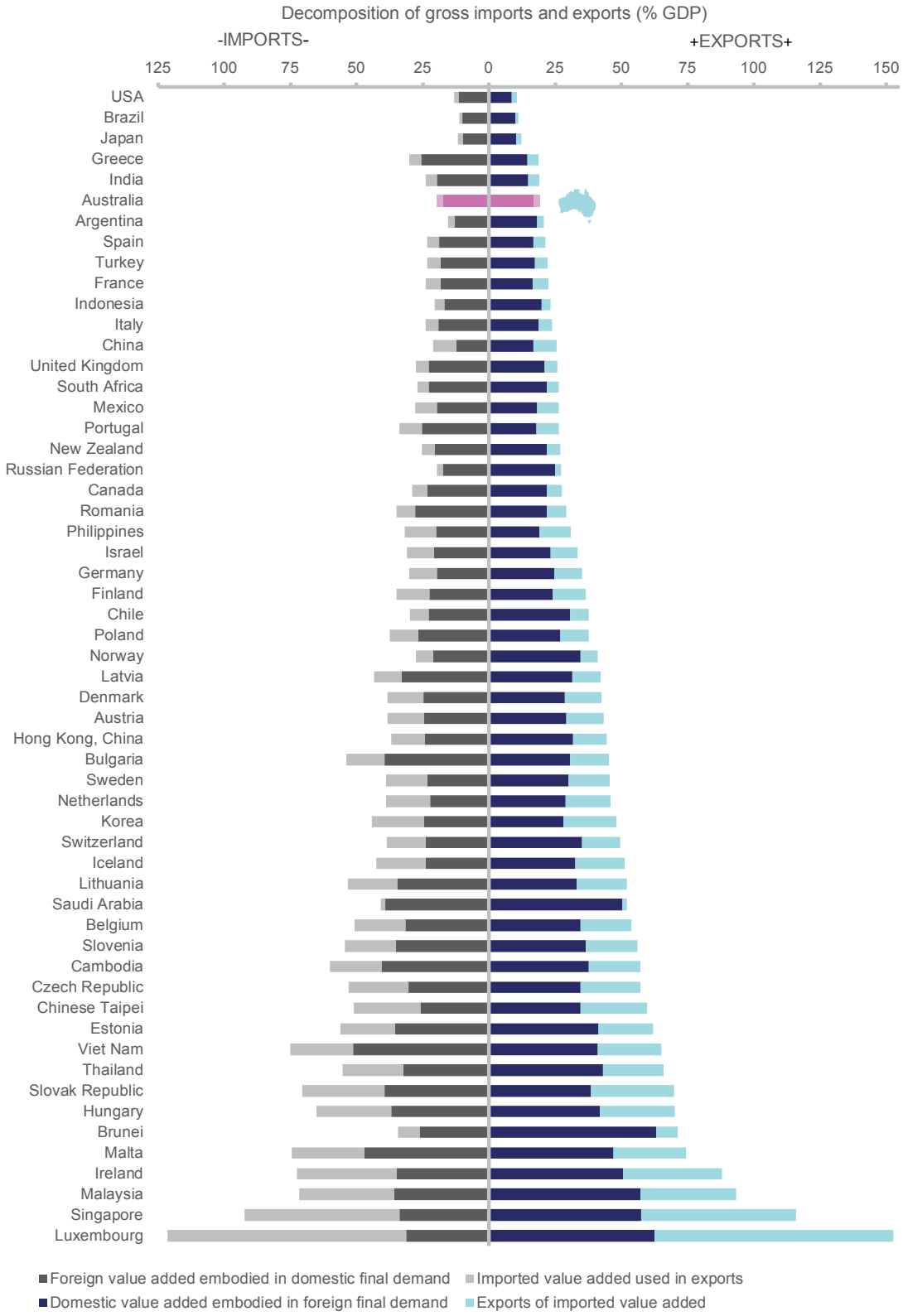
Figure A.19 Economic complexity index (2010) in OECD countries



Source: Hausmann R & Hidalgo, C et al. (2013) The atlas of economics complexity: mapping paths to prosperity, Center for International Development, Harvard University.

A.4 Chapter 4

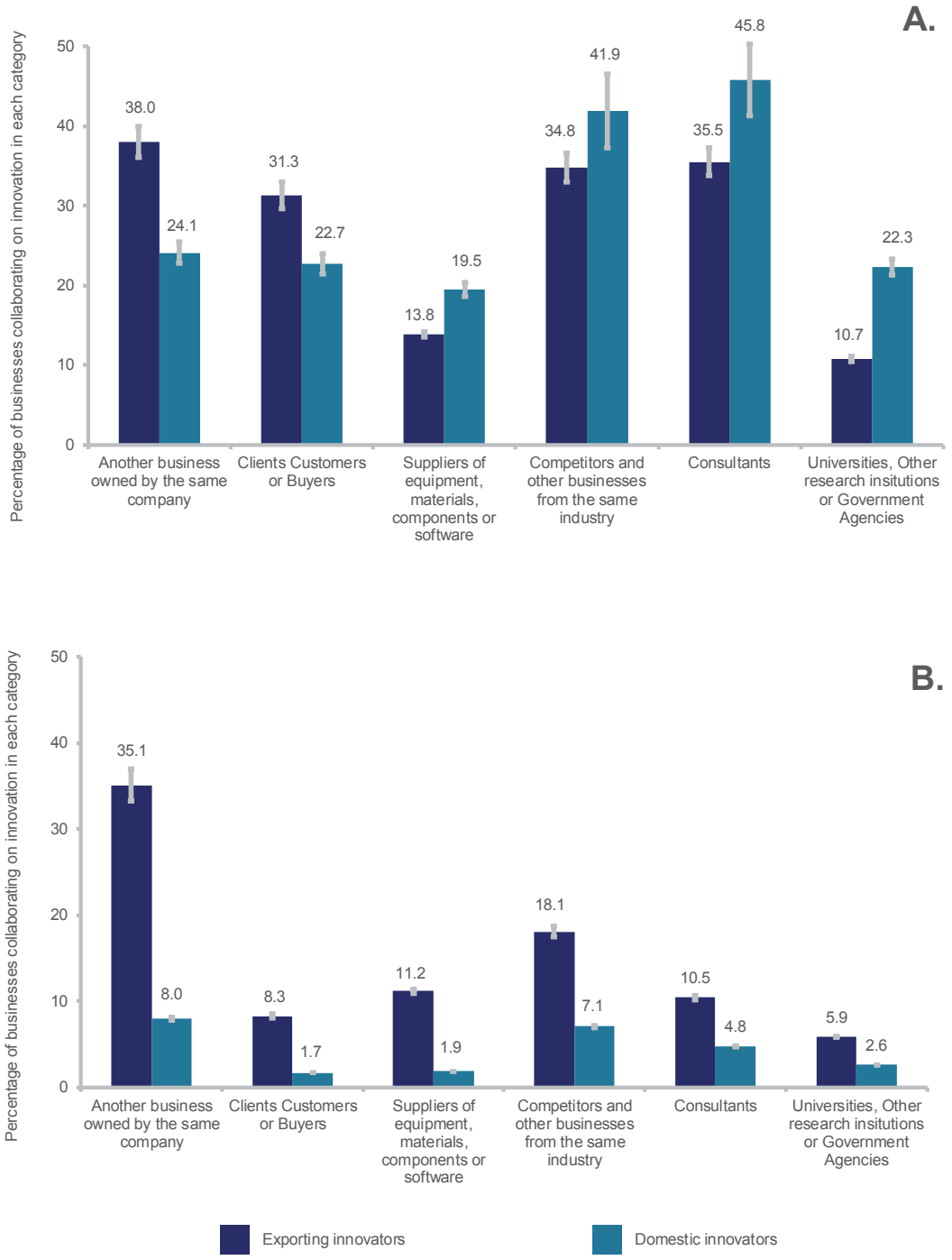
Figure A.20 Trade linkages in global value chains, by country, 2009



Source: OECD–WTO, Trade in Value-Added (TiVA) Database, May 2013.

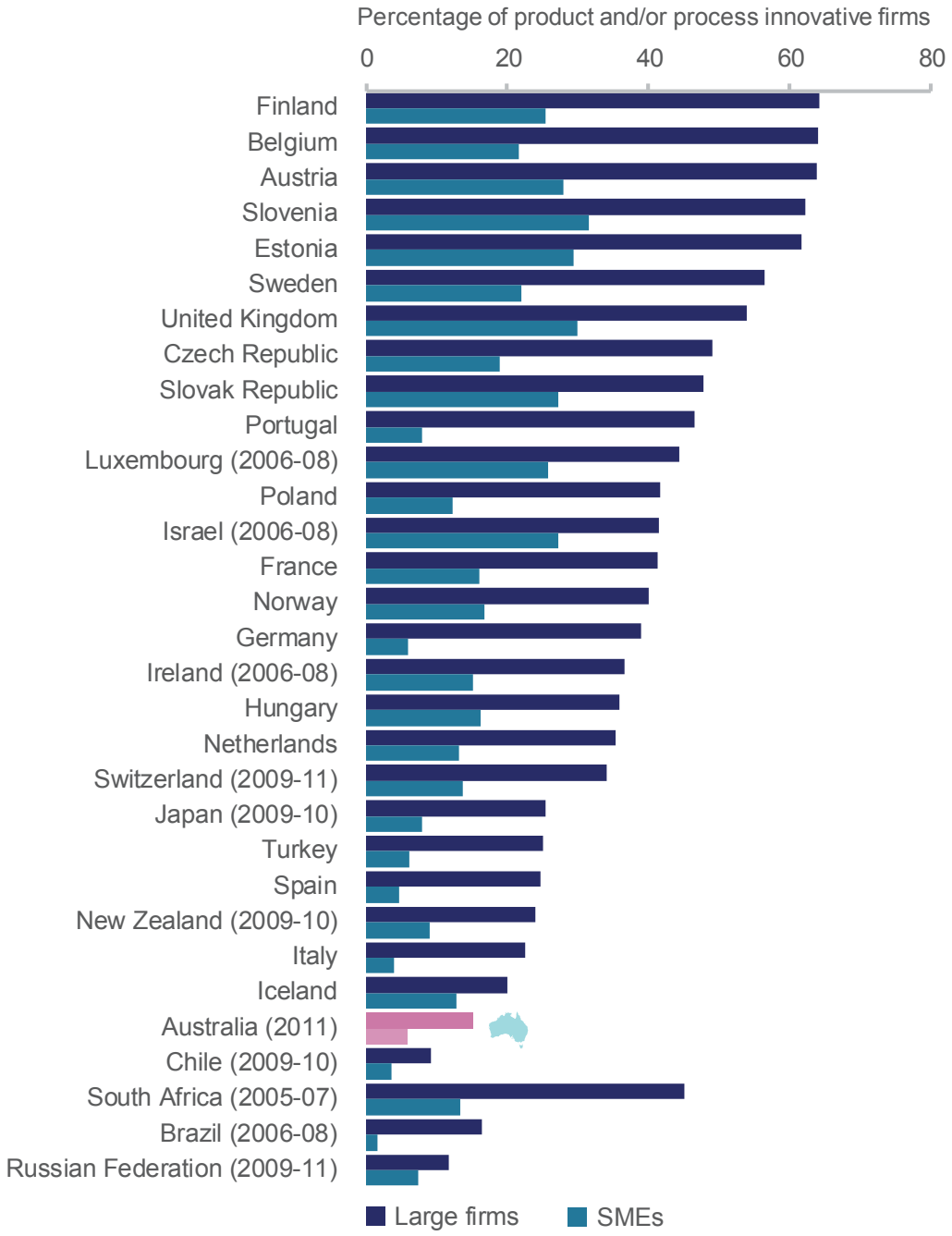
A.5 Chapter 5

Figure A.21 Large business partners for domestic (A) and international (B) collaboration on innovation, by export status, 2010–11



Source: ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

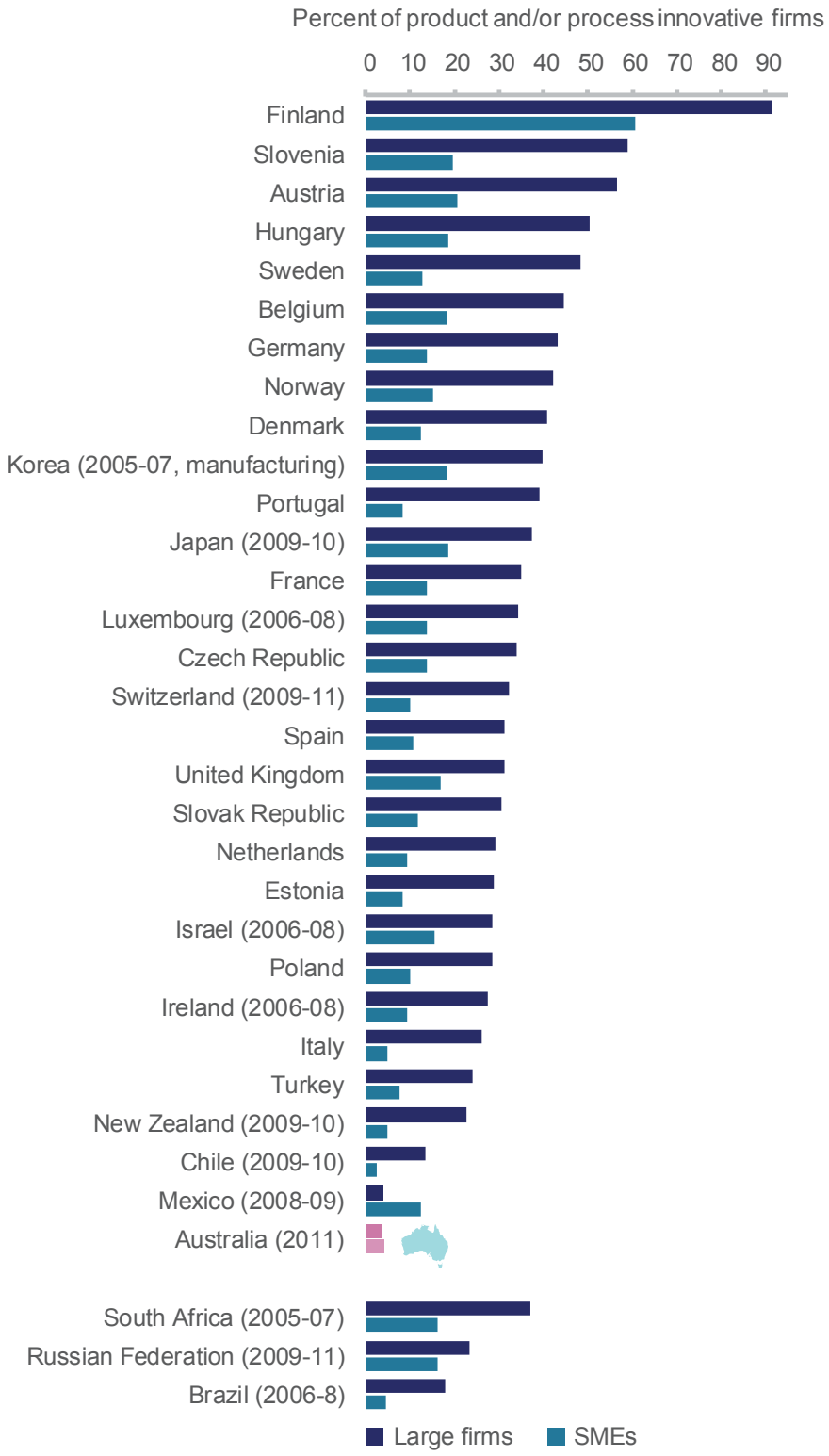
Figure A.22 Firms engaged in international collaboration, by firm size, 2008–10



Note: For Australia, data refer to financial year 2010–11 and include product, process, marketing and organisational innovative firms (including ongoing or abandoned innovation activities). For additional notes, see source.

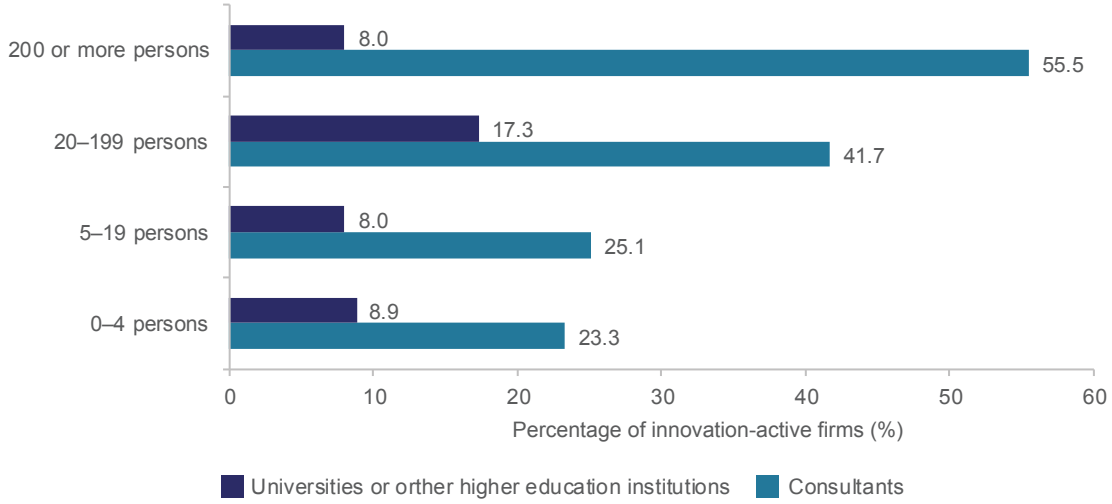
Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013.

Figure A.23 Firms collaborating on innovation with higher education or public research institutions, by firm size, 2008–10



Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013.

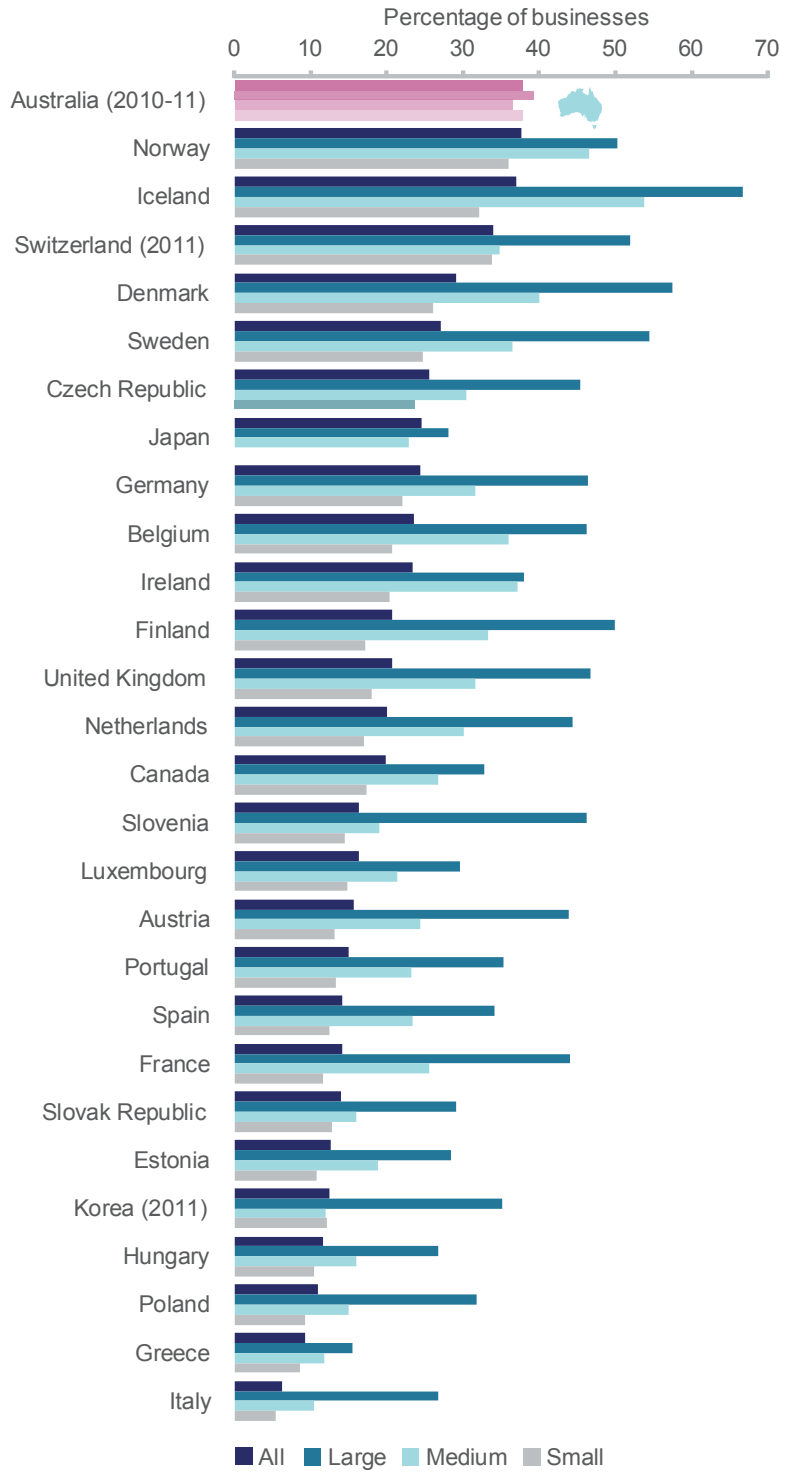
Figure A.24 Business collaboration on innovation with universities and other higher education institutions and consultants, by business size, 2012–13



Source: ABS (2014) Innovation in Australian business, 2012–13, cat. no. 8158, ABS, Canberra.

A.6 Chapter 6

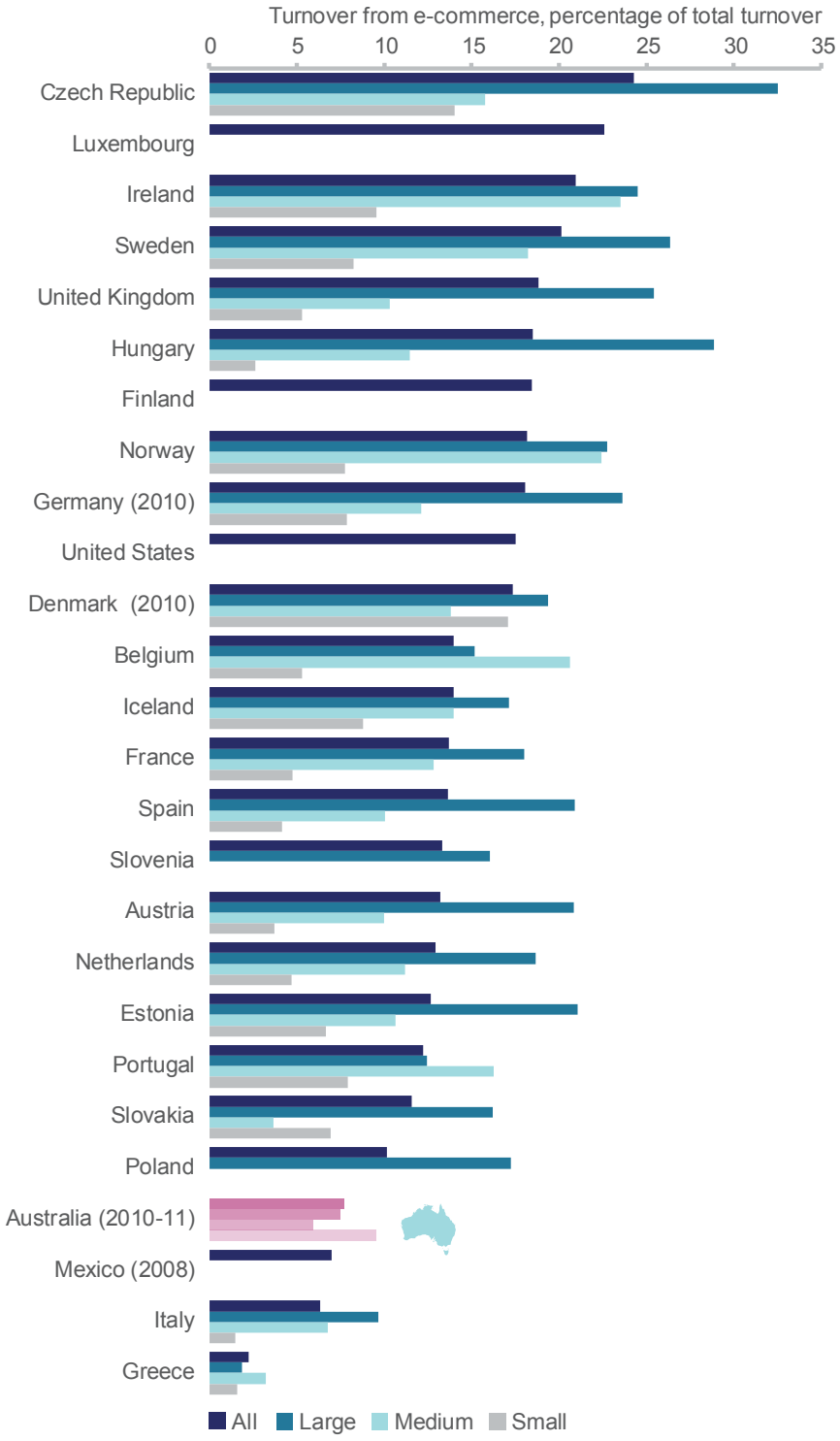
Figure A.25 Businesses selling online, by size, by country, 2012



Notes: Except otherwise stated, the sector coverage consists of all activities in manufacturing and non-financial market services. Only enterprises with 10 or more persons employed are considered. Size classes are defined as: small (from 10 to 49 persons employed), medium (50 to 249), large (250 and more). For Australia, data refer to the fiscal year ending 30 June 2011 (2010–11) instead of 2012. Total includes agriculture, forestry and fishing. See source for additional country notes.

Source: OECD ICT Database and Eurostat, June 2013.

Figure A.26 Business turnover from e-commerce, by size, by country, 2012

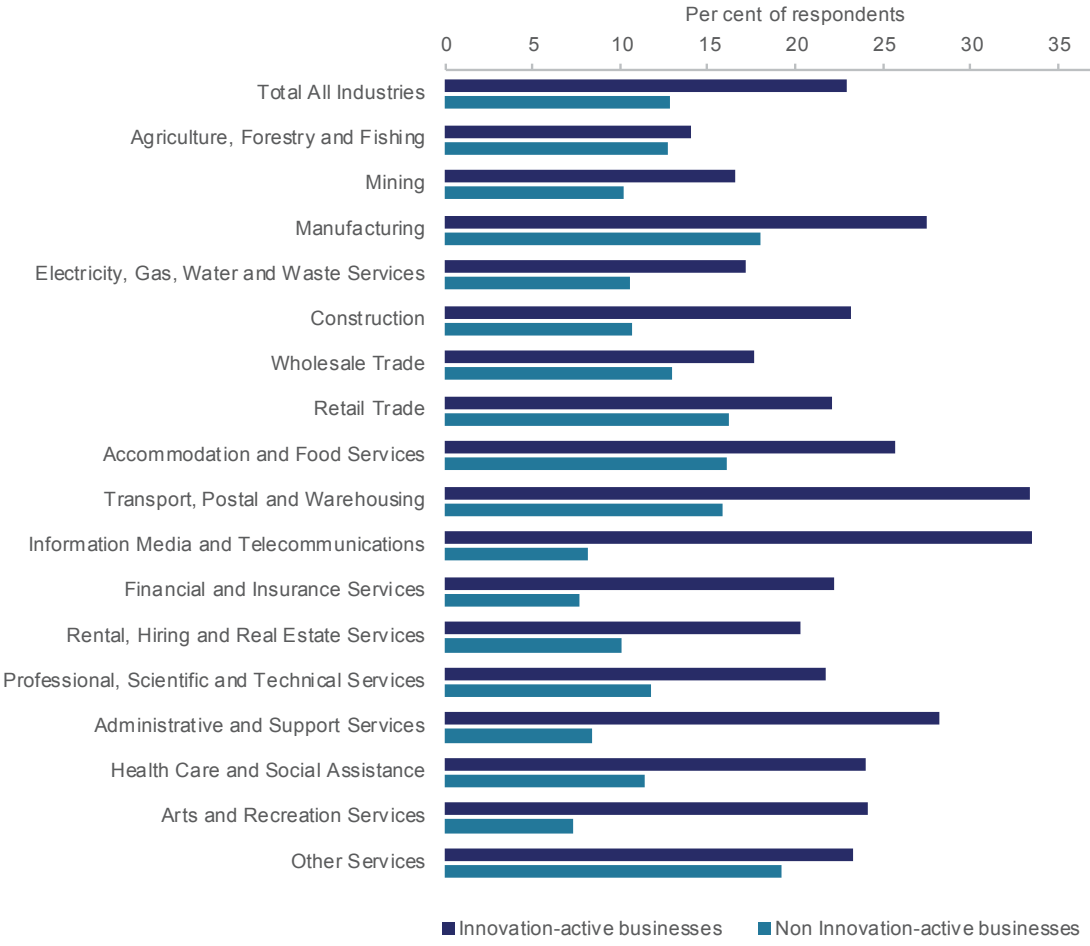


Notes: Except otherwise stated, the sector coverage consists of all activities in manufacturing and non-financial market services. Only enterprises with 10 or more persons employed are considered. Size classes are defined as: small (from 10 to 49 persons employed), medium (50 to 249), large (250 and more). For Australia, data refer to the fiscal year ending 30 June 2011 (2010–11) instead of 2012. Total includes agriculture, forestry and fishing. See source for additional country notes.

Source: OECD, ICT Database; Eurostat and national sources, June 2013.

A.7 Chapter 7

Figure A.27 Lack of skills as a barrier to innovation, by innovation status, by industry sector, 2012–13



Source: ABS (2014) Innovation in Australian businesses, 2012–13, cat. no. 8158.0, ABS, Canberra.

Appendix B. Profile of innovative exporters

Very few industry sectors in Australia export more than 50% of their total output. Notable exceptions are coal mining (91%) and metal ore mining (58%).[341] Technical, vocational and tertiary education services had an export intensity of 17%. The majority of industry sectors are dependent on either households, and government or other industry sectors for business.

Australian exports totalled $300 billion[342] (20% of GDP[343]) in 2012–13. Exports have increased at a compound annual growth rate of 2.9% in the past five years—only marginally above inflation. Export growth accelerated at the start of 2013, driven by higher mining and manufacturing exports.

The distribution of exports is uneven across industry sectors and business sizes (Table B.1). Average exports are calculated by dividing the exports volumes by the numbers of firms.[344] The data show that the average export income of large mining businesses in Australia ($537.2 million) is about ten times the average exports of all industries ($55.6 million).

The sectoral difference between small and medium-sized enterprises (SMEs) and large businesses in terms of average export income is high. This trend has remained mostly unchanged since 2006–07. An exception would be large agricultural businesses that grew 35% annually between 2006–07 and 2012–13 (from $22.9 million to $79.7 million). Both manufacturing and retail trade had negative growth during this period, which was due to a decrease in exports by large firms.

The majority of Australian exporters are not exclusively exporters; they rely heavily on the domestic market for revenue (see Table 2.2). According to the International Business Survey,[345] of some 1500 exporting

341 Data shows that rail transport exports more than 50% of its output. In the case of this sector (as road transport), the concept of transport margin applies. Transport margin is associated with the supply of other commodities that are finally consumed domestically or exported. The export component of rail transport (49.7% or $6 billion) results from the sum of the exports attributed to rail transport of all those commodities that are transported via rail, and which are finally exported.

342 ABS (2014) *Characteristics of Australian exporters,* 2013–14, cat. no. 5368.0, ABS, Canberra.

343 ABS (2014) *Australian National Accounts: national income, expenditure and product, June 2014,* Table 32, cat. no. 5206.0, ABS, Canberra.

344 ABS (2014) *Characteristics of Australian exporters,* 2013–14, cat. no. 5368.0, Tables 5.1 and 5.2, ABS, Canberra.

345 Export Council of Australia (2014) *Australia's International Business Survey 2014.*

businesses, 68% of survey respondents indicated that less than 50% of their revenue came from markets outside Australia, and 29% responded that exports represented less than 10% of their total revenue.

Foreign ownership promotes exporting activity (Figure B.1). Firms with at least 50% foreign ownership are more likely to be engaged in exports than firms with less than 50% foreign ownership. This applies for both manufacturing and service sectors, and is more pronounced for financial services (11 times more likely) and manufacturing (7 times more likely). In an open economy, foreign firms may not only look at setting up operations in Australia to access its domestic market, but may also be investing in exporting sectors where international competitiveness is high.

The Australian Bureau of Statistics (ABS) has shown that SME exporters significantly outperform non-exporters across a range of performance measures, such as value-added, wages, sales per employee and average total employment (Figure B.2). These SME exporters had a high propensity to engage in innovation activity (Figure B.2B) as well as a greater degree of foreign ownership and web presence.

Table B.1 Average export income of Australian firms, by firm size and industry sector, 2012–13

	Agriculture	Mining	Manufacturing	Construction	Wholesale Trade	Total industry
Average large business, $m	79.7	537.2	30.0	3.6	26.3	55.6
Average medium business, $m	1.1	1.3	0.7	0.3	0.6	0.5
Average small business, $m	0.12	0.14	0.08	0.06	0.10	0.08

Source: ABS (2014) Characteristics of Australian exporters, 2012–13, cat. no. 5368055006, Tables 5.1 and 5.2. Department of Industry calculations.

B.1 The competitive environment

Domestic competition and rivalry is one of the most important factors in the creation of a firm's competitive advantage.[346] Competition is also major driver of business performance and innovation.[347]

Australia ranks 11th out of 143 countries on the intensity of local competition.[348] Most Australian businesses (around 60%) in 2012–13 faced similar levels of competition (five or more competitors; Figure B.3). Sectoral data (not shown) shows that the services sector in general faces the highest levels of competition, with the exception of the information, telecommunications and media sector.[349]

Of all businesses that neither innovated nor exported, 20% report having no competition (Figure B.3). This may indicate the existence of domestic captive, regional or niche markets that have idiosyncratic characteristics or the presence monopolistic regimes.[350] There is a high concentration of agriculture, fisheries and forestry, and mining businesses in this category at 45% and 44%, respectively, and a lower concentration in retail trade, construction and wholesale trade.[351] A significantly smaller proportion of businesses that were either exporting (11%) or innovating (9%), or both (5%) reported monopoly conditions.

346 Porter ME (1990) *Competitive advantage of the nations,* Free Press, New York.

347 Soames L et al. (2011) *Competition, innovation and productivity in Australian businesses,* Productivity Commission and Australian Bureau of Statistics research paper, cat. no. 1351.0.55.035.

348 Cornell University, INSEAD & WIPO (2014) *The Global Innovation Index, 2014: the human factor in innovation,* Fontainebleau, Ithaca and Geneva.

349 ABS (2014) Customised data based on the Business Characteristics Survey produced for the Australian Government Department of Industry.

350 These could be temporal or geographical in nature.

351 ABS (2014) Customised data based on the Business Characteristics Survey produced for the Australian Government Department of Industry.

Manufacturing sectors face the highest levels of import competition. There were 28 sectors in Australia where competition from imports exceeds 30% in 2009–10 (Figure B.4). These sectors were all manufacturing sectors of the economy. Competition had increased in most of these sectors in the five years before 2009–10. Comparisons with 2005–06 data show that, in some sectors, import competition has displaced local production quite dramatically (e.g. import competition for motor vehicles and car manufacturing went from 42% to 58%) during a period of relatively stable currency values.[352]

The data may suggest a lack of competitiveness of the Australian car industry in comparison to imported products. Part of the car and parts imports that displaced local production came from car manufacturers in high-wage countries such as Germany. Innovation incorporated in German products in terms of quality, safety and new features is one important reason why some of the leading brands have increased market share in the Australian market.

Although Australian-made vehicles also incorporate recent innovations with regard to quality, safety and new features, market conditions have contributed to the sector's decline in competiveness. Australia has one of the most open and fragmented new vehicle markets in the world, with 67 brands competing for just over one million sales per year. In contrast, the United States (US) market consists of around 45 brands competing for more than 15 million sales per year. Recent years have also seen a shift in consumer preference towards small cars and sports utility vehicles, rather than large and medium cars such as the Holden Commodore, the Ford Falcon, and the Toyota Camry and Aurion.

In the basic chemicals manufacturing sector, domestic production was able to displace imports. Domestic production substituted imports by 8%, reflecting an improvement in cost competitiveness of Australian production in this sector. There have also been very high levels of research and development (R&D) investment and process innovation (Table 2.2).[353] It is also worth noting that exports of basic chemicals increased from $1.8 billion to $4.3 billion between 2005–06 and 2009–10.[354] Revealed comparative advantage (RCA) values are still much less than one in basic chemicals, showing that the sector still has potential to expand into international markets.

352 The Australian dollar in 2005–06 and 2009–10 was relatively favourable compared to the Euro and US dollar.

353 Basic chemicals are standardised commodities and innovation takes place mainly through improved processes.

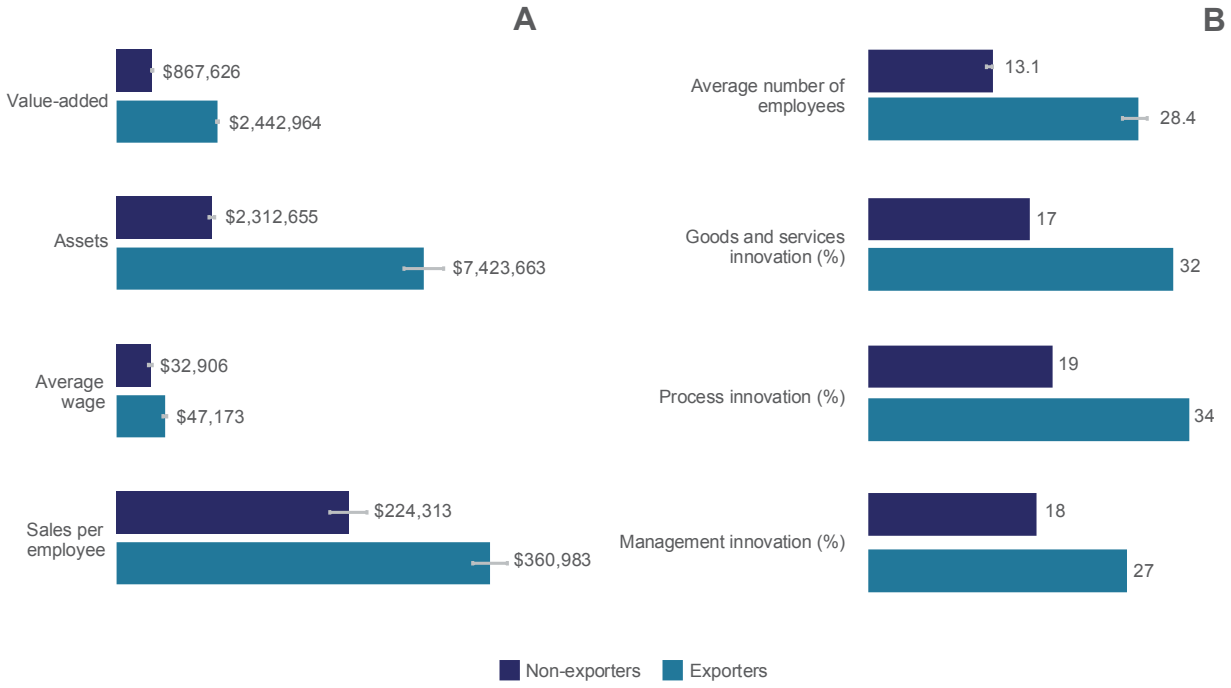
354 ABS (2013) *Australian National Accounts: input–output tables*, 2009–10, Table 2, cat. no. 5209.0.55.001; and ABS (2009) *Australian National Accounts: input–output tables*, 2005–06, Table 2, cat. no 5209.0.55.001.

Figure B.1 Proportion of businesses receiving income from exports, by foreign ownership in selected industry sectors, 2012–13

Note: Data are not available for all industry sectors.

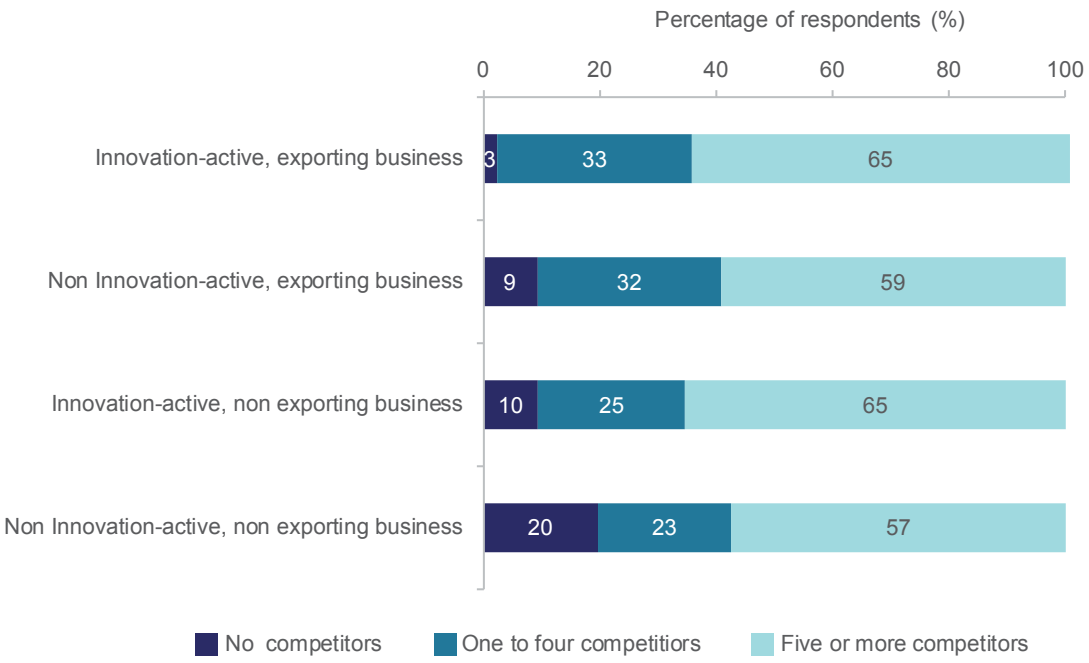
Source: ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

Figure B.2 Performance measures (A&B) and levels of innovation (B) in Australian SMEs by export status, 2006–07



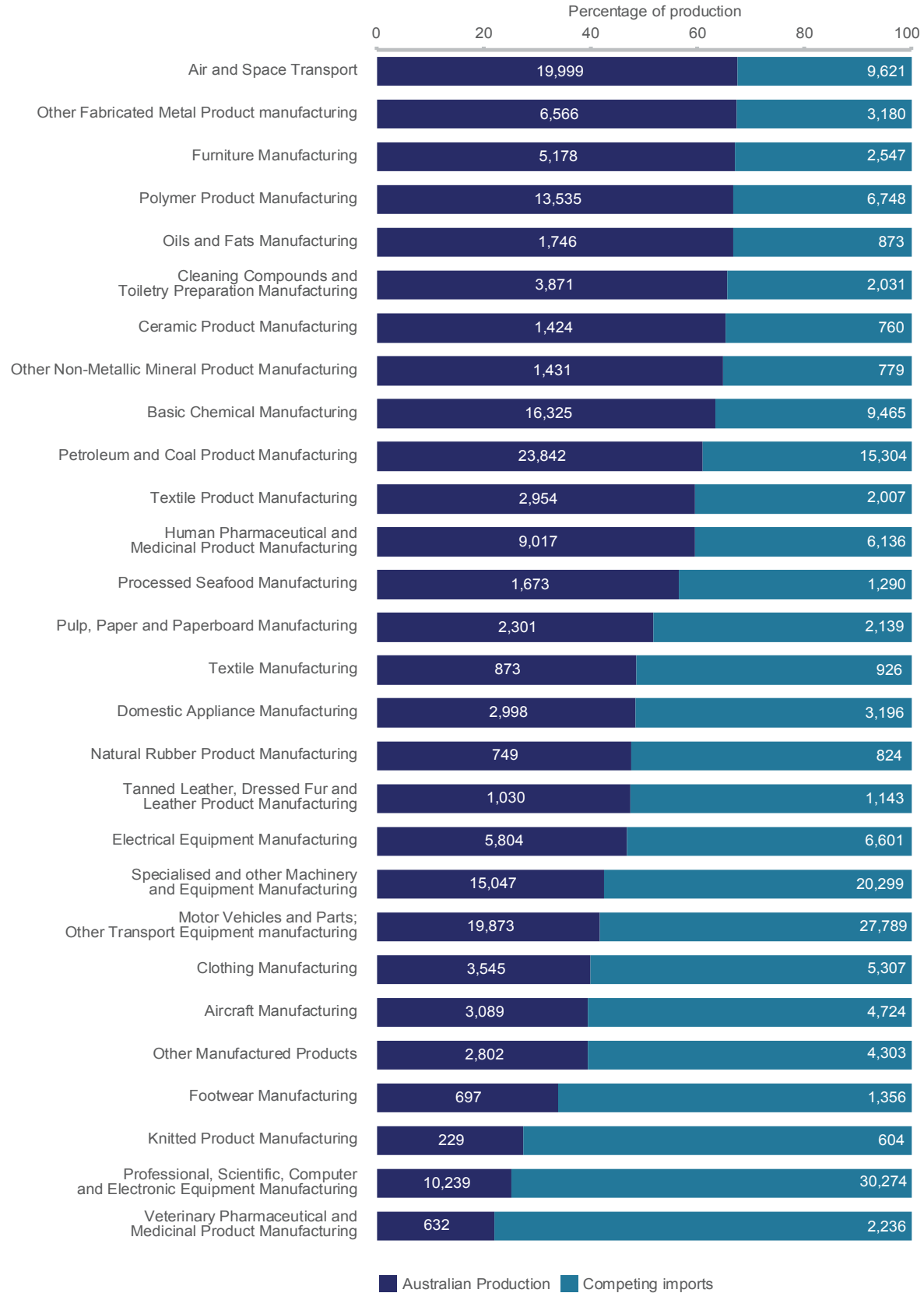
Source: Hansell D & Talgaswatta T (2010) Business characteristics of small and medium sized Australian exporters, Australian Economic Indicators, Jan 2010, cat. no. 1350.0, www.abs.gov.au/AUSSTATS/abs@.nsf/7d12b0f6763c78caca257061001cc588/828b18390f4db7c2ca2570f80015107a!OpenDocument.

Figure B.3 Level of competition faced by Australian businesses, by export and innovation status, 2012–13



Source: ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

Figure B.4 Australian production versus competing imports in industry sectors with at least 30% import competition, 2009–10



Notes: Labels are total production in A$ million.

Source: ABS (2013) Australian National Accounts: input–output tables, 2009–10, Table 2, cat. no 5209.0.55.001.

B.2 Drivers of innovation for exporting businesses

Firms are driven to innovate for a range of reasons. Many of these reasons are captured in the ABS Business Characteristic Survey. Figure B.5 disaggregates the reasons for innovation. It contrasts firms that reported being driven to innovate to increase exports with firms that were not seeking to increase exports through innovation.

It is clear that innovative businesses that are export orientated are more likely to report 'yes' to all reasons for innovating. These drivers range from market-based reasons to more safety, quality and environmental reasons for innovating.

The likelihood of targeting export markets increases through innovation. Compared with firms not targeting exports, export-oriented innovators are almost three times more motivated to establish new markets through innovation (85.9%; Figure B.5).

For microsized firms (0–4 employers) the percentage is 94% compared with 77% for large business.[355] These data are about motivations for innovation. Business performance indicators suggest that innovation is a useful tool for increasing exports and targeting new export markets (Chapter 2). Small businesses may be motivated to establish new export markets through innovation, but may lack other capabilities or resources that limit their success.[356]

Significant differences are observed between the two types of innovators in three responses: being at cutting edge of the industry, competitive pricing and establishing new markets. There is a link in exporters' minds between growing exports, and being at the cutting edge of the industry and maintaining competitive prices through innovation. These data also confirm research findings on how new-to-market innovation helps drive international competitiveness and global value chain participation (see Chapters 2 and 4).

B.3 Expenditure on innovation and export activity

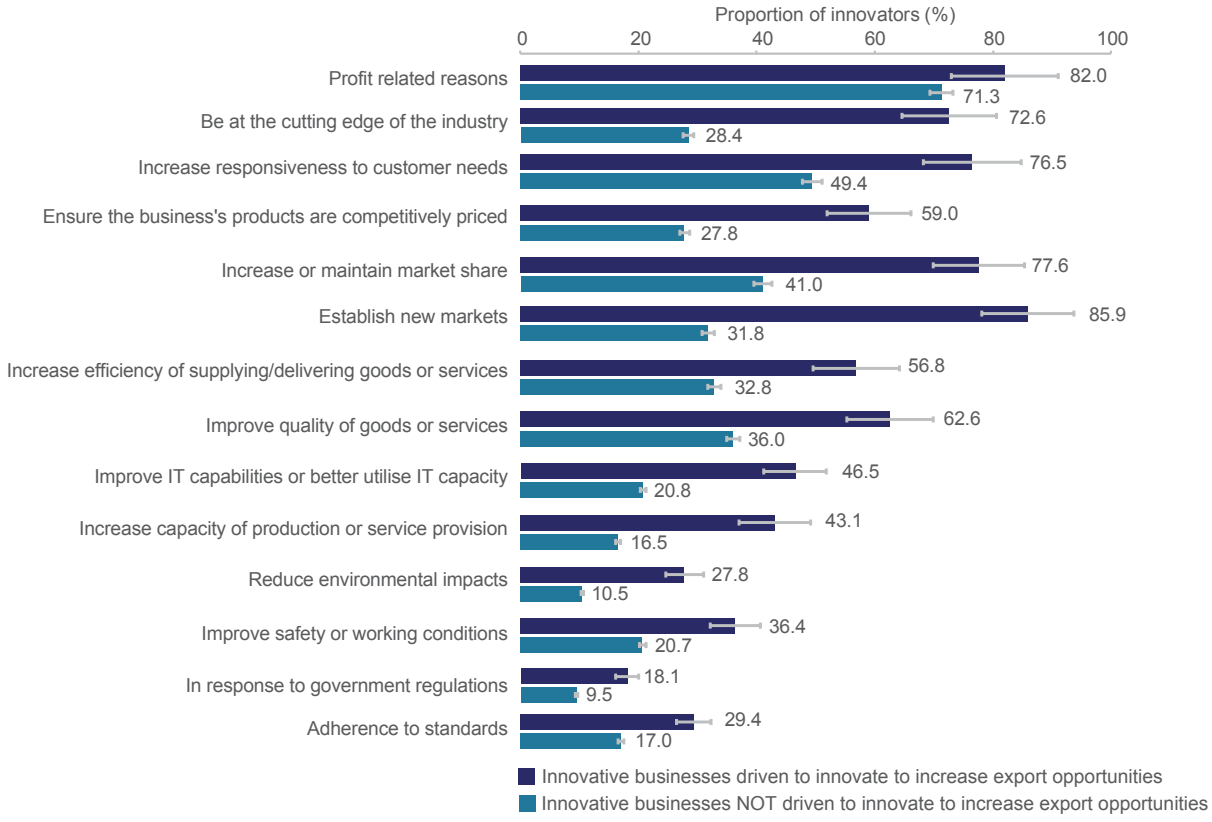
The areas of priority for innovation expenditure in a business vary significantly by export status (Figure B.6). Although there is not a major difference in the percentages of exporting and non-exporting firms in respect to the expenditure in machinery and equipment (including software) and training, there are notable differences in R&D-related expenditure, design and intellectual property (IP) aquisition. Innovative exporters are twice as likely to invest in R&D, three times more likely to invest in design and 25% more likely to buy IP than domestic innovators (Figure B.6).

Interestingly, small (43%) and medium size (50%) firms that export show higher proportions of firms spending in R&D than large exporting firms. The data suggest that exporting firms (particularly SMEs) require products and services that have incorporated R&D or need R&D support. These data reaffirm the fact that novelty, uniqueness and high quality are important preconditions to compete in export markets.

355 ABS (2014) Australian Government Department of Industry customised output based on the Business Characteristics Survey.

356 ACOLA (2014) *The role of science, research and technology in lifting Australian productivity,* Securing Australia's future Project 4 final report, www.acola.org.au.

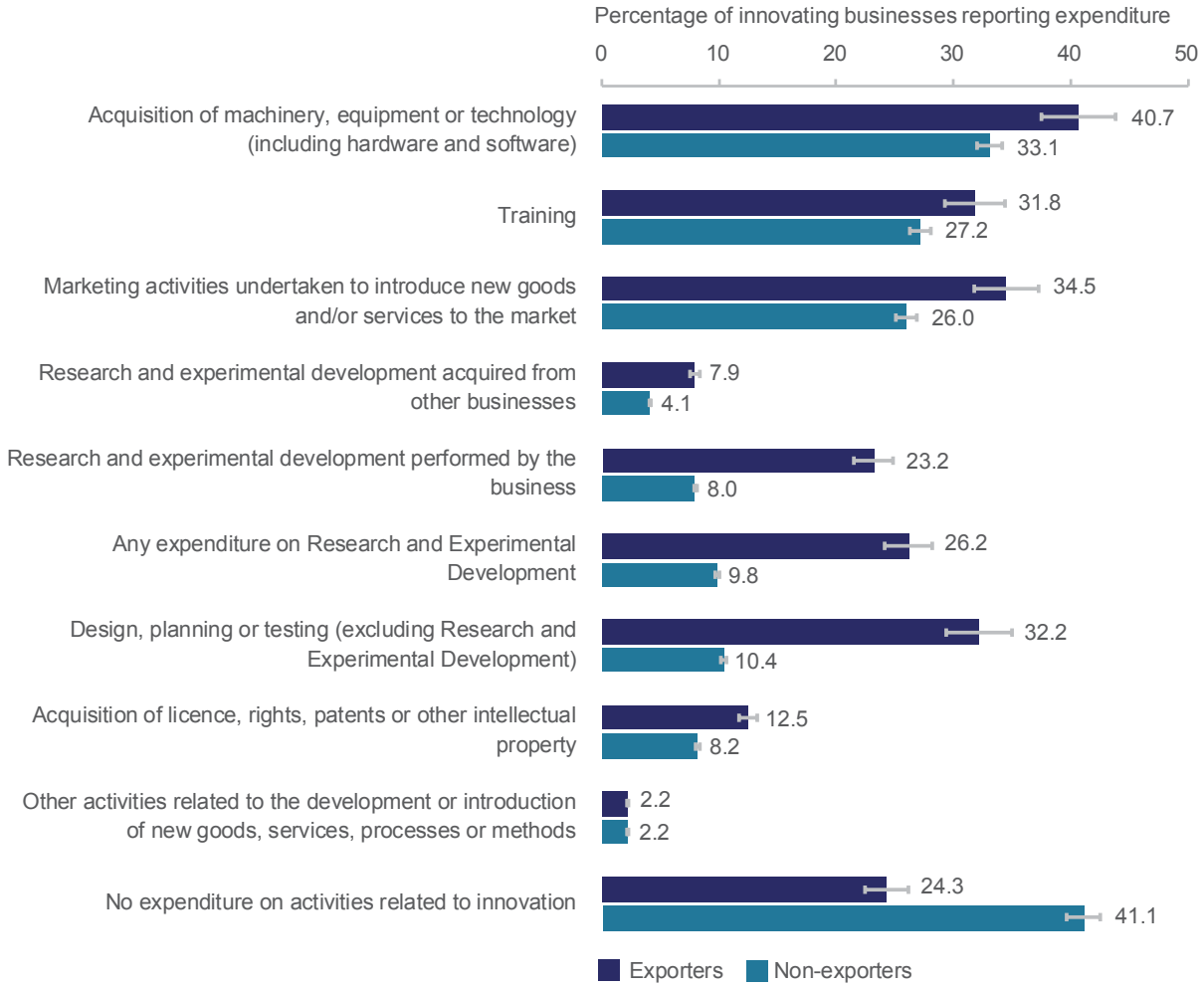
Figure B.5 Drivers of innovation by export orientation, 2012–13



Notes: Businesses were split into the two categories if they reported innovating to increase export opportunities.

Source: ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

Figure B.6 Areas of innovation expenditure for innovation-active businesses, by export status, 2012–13



Source: ABS (2014) Customised report based on the Business Characteristics Survey data commissioned by the Australian Government Department of Industry.

Abbreviations and acronyms

Abbreviations and acronyms	
ABS	Australian Bureau of Statistics
BCS	Business Characteristics Survey
BERD	business expenditure on research and development
EIC	economic complexity index
EU	European Union
FDI	foreign direct investment
GDP	gross domestic product
GERD	gross expenditure on research and development
HERD	higher education expenditure on research and development
ICT	information and communications technology
IP	intellectual property
IT	information technology
OECD	Organisation for Economic Co-operation and Development
PPP	purchasing power parity
R&D	research and development
RCA	revealed comparative advantage
SME	small and medium-sized enterprise
UNCTAD	United Nations Conference on Trade and Development
US	United States
UK	United Kingdom
VET	vocational education and training

Glossary

Backward participation

Backward participation measures the value of imported inputs in the overall exports of a country (the remainder being the domestic content of exports). This indicator provides an indication of the contribution of foreign industries to the exports of a country by looking at the foreign value-added embodied in the gross exports.

Business size

According to the Australian Bureau of Statistics:

- large businesses are considered those employing 200 or more persons
- medium-sized enterprises are those employing 20 to 200 persons
- small firms are those employing between 5 and 19 persons
- microbusinesses are those employing less than 5 people
- non-employing businesses are those run by their owners.

Small to medium-sized enterprises (SMEs) are defined as businesses that employ 1–199 persons.

Note that the Organisation for Economic Co-operation and Development defines SMEs as firms that employ 10–250 employees, whereas the United States considers SMEs to include firms with fewer than 500 employees.

Business Characteristics Survey

The Business Characteristics Survey (BCS) is an annual survey, and is the vehicle for the ABS's Integrated Business Characteristics Strategy. The strategy is designed to integrate the collection and quality assurance of data required for input into both the ABS's Business Longitudinal Database and the production of point in time estimates for the use of information technology, innovation and a broad range of other non-financial characteristics.

A key part of the BCS is a detailed set of questions on business innovation asked every second year. This is why some business innovation data presented in this report are only available every second year. The detailed survey includes questions on drivers, sources of ideas and collaboration for innovation.

Collaboration

Collaboration amounts to interactions both among and between organisations, and their surroundings. Systems approaches often highlight linkages as the most vital area for promoting innovation activity. These interactions can consist of informal contacts and information flows, or more formal collaboration on innovation projects. They include adjustments in the value chain, such as closer relationships with suppliers or users, or research on market demand or on the potential uses for technologies. Firms may have close relationships with other firms within an industry cluster, global supply or production chain, or be part of looser networks. They may draw on published work from public research institutions or work directly with them on collaborative projects. The lowest level of links between firms is when a firm draws on information belonging to another firm that is openly available and that does not require the purchase of technology or intellectual property rights, or interaction with the source. Linkage may also involve acquisition of knowledge and technology through procurement of external knowledge and/or purchase of capital goods and services

(machinery, equipment and software) that have knowledge and technology embodied in them. The benefits of linkages will depend on how well knowledge is shared throughout the enterprise and channelled into the development of new products, processes and other innovations.

Competitiveness

The competitiveness of trade-exposed firms is defined as their ability to succeed in international competition against leading international competitors. For firms that are non-trade exposed, competitiveness is defined by their ability to be as efficient and effective as global leaders in their industry.

Competitive advantage

Competitive advantage is the value a firm is able to create for its buyers that exceeds the firm's cost of creating it. Value is what buyers are willing to pay, and superior value stems from offering either lower prices than competitors for equivalent benefits or providing unique benefits that more than offset a higher price.

Economic complexity

Economic complexity is expressed in the composition of a country's productive output, and reflects the structures that emerge to hold and combine knowledge. Ultimately, the complexity of an economy is related to the multiplicity of useful knowledge embedded in it. For a complex society to exist, and to sustain itself, people who know about design, sales and marketing, finance, technology, human resource management, operations and trade law must be able to interact and combine their knowledge to make products. These same products cannot be made in societies that are missing parts of this capability set. Increased economic complexity is necessary for a society to be able to hold and use a larger amount of productive knowledge.

Economic complexity index

The economic complexity index (ECI) is a holistic measure of the production characteristics of large economic systems, usually whole countries. As most of the measurements used in complexity economics, the goal of this index is to explain an economic system as a whole rather than the sum of its parts. The ECI looks to explain the knowledge accumulated in a country's population and that is expressed in the country's industrial composition. To achieve this goal, the ECI combines metrics of the diversity of countries and the ubiquity of products to create measures of the relative complexity of a country's exports. The product equivalent of the ECI is the product complexity index.

Entrepreneurship

Entrepreneurship has been typically referred to as a creative, risky and innovative idea, activity or process that is converted into new products, processes and organisational forms that enhance economic development and growth. Despite definitional differences, it is generally agreed that entrepreneurship is both a driving force of and a challenge for young start-ups that lack funds, human capital and relevant experience.

Export and import of goods and services

Exports of goods and services consist of sales, barter, or gifts or grants, of goods and services from resident to non-residents. Imports consist of purchases, barter, or receipts of gifts or grants, of goods and services by residents from non-residents. International transactions in services differ in many respects from those in goods. The production and the delivery of a service is usually a single operation carried out by mutual agreement between producer and consumer, which requires some kind of previous contact between them.

Goods covers general merchandise, goods for processing, repairs on goods, goods procured in ports by carriers, and nonmonetary gold. In accordance with general balance of payments principles, change of ownership is the principle determining the coverage and time of recording of international transactions in goods. Exports and imports of goods are recorded at market values at points of uniform valuation—that is, the customs frontiers of exporting economies.

Forward participation

Forward participation is the share of exported goods and services used as imported inputs to produce other countries' exports. This indicator gives an indication of the contribution of domestically produced intermediates to exports in third countries.

Framework conditions

The efficacy of an innovation system often hinges upon the quality of framework conditions, namely the capacity to ensure an innovation-friendly environment. This is shaped not only by research and development, but also by the interplay of factors that enable knowledge to be converted into new products, processes and organisational forms. In turn, these enhance economic development and growth. Framework conditions encompass the quality and reach of governance in a country, an effective banking and financial system, an honest and functioning judiciary, and working educational and health systems.

Global value chains

Global value chains are the embodiment of global collaboration on innovation fuelled by growing international trade, global competition and greater fragmentation of production processes.

Gross domestic product

Gross domestic product (GDP) can be defined according to three different methods:

- Output-based definition: GDP is an aggregate measure of production equal to the sum of the gross values added of all resident institutional units engaged in production (plus any taxes, and minus any subsidies, on products not included in the value of their outputs). The sum of the final uses of goods and services (all uses except intermediate consumption) measured in purchasers' prices, less the value of imports of goods and services, or the sum of primary incomes distributed by resident producer units.
- Expenditure-based definition: Expenditure-based GDP is total final expenditures at purchasers' prices (including the f.o.b. value of exports of goods and services), less the f.o.b. value of imports of goods and services.
- Income-based definition: Income-based GDP is compensation of employees, plus taxes less subsidies on production and imports, plus gross mixed income, plus gross operating surplus.

Industry sector definitions

For indicators for which internationally comparable data exist, the industry sectors have been defined in accordance with the International Standard Industrial Classification of All Economic Activities (ISIC), Rev.3.

For national data, industry sectors are defined according to the 2006 Australian and New Zealand Standard Industrial Classification (ANZSIC).

Gross value-added

In economics, gross value-added (GVA) is a measure of the value of goods and services produced in an area, industry or sector of an economy. In national accounts, GVA is output minus intermediate consumption; it is a balancing item of the national accounts' production account

GVA = GDP + subsidies – (direct, sales) taxes

Knowledge diffusion

The flow of knowledge and technology is at the core of what is often referred to as knowledge diffusion. Knowledge diffusion is relevant both for identifying the economic effects of innovation and for establishing the shape of an enterprise's network. As with highly interactive linkages, knowledge diffusion is influenced by concerns over knowledge leakages and the methods enterprises use to protect their intellectual property.

Knowledge management

Knowledge management involves practices for gaining external knowledge and interacting with other organisations, and for sharing and using knowledge within the enterprise.

Knowledge networks

Knowledge networks facilitate the exchange of technology and commercial information. Informal networks tend to be based on personal contacts or 'communities of practice', or simply arise in the normal course of business. Formal or managed networks can be organised by business organisations such as chambers of commerce, research associations, technology services companies, consultants, universities or public research organisations, or sponsored by local, regional or central governments.

Innovation

An innovation is the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations.

Four types of innovation are distinguished:

- Product innovation. The introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness, or other functional characteristics.
- Process innovation. The implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.
- Marketing innovation. The implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.
- Organisational innovation. The implementation of a new organisational method in the firm's business practices, workplace organisation or external relations.

Innovation activity

Innovation activities are all scientific, technological, organisational, financial and commercial steps that lead, or are intended to lead, to the implementation of innovations. Some innovation activities are themselves innovative; others are not novel activities, but are necessary for the implementation of innovations.

Innovation activities also include research and development that is not directly related to the development of a specific innovation.

Innovation-active businesses

An innovation-active business is one that has undertaken any innovative activity during the period under review, including those with ongoing and abandoned activities.

Innovation system

In this document, innovation system is defined as an open network of organisations both interacting with each other and operating within framework conditions that regulate their activities and interactions. Three components of the innovation system—networks, innovation activities and framework conditions—collectively function to produce and diffuse innovations that have, in aggregate, economic, social and/or environmental value.

Intangible capital

Intangible capital includes assets such as data, software, designs, new organisational processes, management quality, research and development, patented technology, reputation (brand equity) and firm-specific skills.

Intellectual property rights

Clear intellectual property (IP) rights are vital for improving incentives to innovate in some industries, particularly high-technology sectors where research and development plays a central role in innovation. Laws and regulations are part of the framework in which firms operate. Well-designed regulations and standards can provide a strong signal to support and guide innovative activities. They affect access to information, property rights, tax and administrative burdens (in particular for small firms). Some enterprises may even avoid some types of highly complex links if they have concerns about the loss of IP. A number of methods are used for protecting IP:

- patents
- design registration
- trademarks
- copyrights
- confidentiality agreements and trade secrecy
- secrecy that is not covered by legal agreements
- complexity of product design
- lead time advantage over competitors.

Non-technological innovation

Non-technological innovation covers all innovation activities that are excluded from technological innovation. It includes all the innovation activities of firms that do not relate to the introduction of a technologically new or substantially changed good or service, or to the use of a technologically new or substantially changed process.

Novelty

All innovations must contain a degree of novelty. There are three concepts of the degree of novelty of innovations:

- New-to-firm innovation. The minimum entry level for an innovation is that it must be new to the firm. A product, process, marketing or organisational method may already have been implemented by other firms, but if it is new to a given firm, then it is an innovation to that firm.
- New-to-market innovation. Innovations are new to the market when the firm is the first to introduce the innovation on its market. The market is simply defined as the firm and its competitors, and it can include a geographic region or product line.
- New-to-world innovation. An innovation is new to the world when the firm is the first to introduce the innovation for all markets and industries, domestic and international. New to the world therefore implies a qualitatively greater degree of novelty than new to the market.

Productivity

Productivity is the ratio of a firm's, sector's or economy's outputs to inputs. There are a number of ways to measure productivity. Labour productivity is where the only input being considered is labour (e.g. hours worked). Total factor productivity, or multifactor productivity, typically uses just labour and capital inputs. The KLEMS total factor productivity uses a more comprehensive account of inputs relating gross output to primary (capital and labour) and intermediate inputs (energy, materials, other intermediate goods and services). Productivity growth occurs when growth in industry outputs exceeds growth in inputs.

Relative citation impact

The number of citations for Australian research in a specific field of research as a ratio to the world average citations in that field of research.

Research and development

Research and development (R&D) comprises creative work undertaken on a systematic basis to increase the stock of knowledge—including knowledge of man, culture and society—and using this stock of knowledge to devise new applications.

R&D covers three activities:

- Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.
- Applied research is also original investigation done to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.
- Experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed.

Researchers

Professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems, as well as in the management of these projects.

Research specialisation

Research specialisation is the ratio of the proportion of a country's research publications that are in a particular field to the proportion of the world's research publications that are in that field. A specialisation value of 1.00 would indicate that the field comprises the same proportion of that country's output as it does of world output, while 2.00 would indicate that it comprises twice as high a proportion in the country as in the world. It is important to note that it is quite possible—and even common—to have high specialisations in fields that are only a small proportion of publications.

Revealed comparative advantage

Revealed comparative advantage (RCA) is an index calculated using exports, providing a measure of relative specialisation of a country's export activities in an industry. The RCA is calculated as the proportion of a country's exports in that industry divided by the proportion of world exports in that industry. If the RCA is greater than one, a comparative advantage is 'revealed.' If the RCA is less than one, the country has a comparative disadvantage in that industry.

Science and engineering degrees

Science degrees include the life sciences, the physical sciences, mathematics and statistics, and computing. Engineering degrees comprise engineering and engineering trades, manufacturing and processing, and architecture and building.

Trade in value-added

Traded-exposed goods and services are composed of inputs from various countries around the world. However, the flows of goods and services within global production chains are not always reflected in conventional measures of international trade. The joint Organisation for Economic Co-operation and Development – World Trade Organization Trade in Value-Added initiative addresses this issue by considering the value added by each country in the production of goods and services that are consumed worldwide.

Trademarks

Trademarks are the outcome of establishing recognisable designations and symbols for goods and services, as well as firms' identities. They play a crucial role in the process of marketing innovations, being instrumental in differentiating the attributes of goods and services in the marketplace. Trademark data are considered a useful complementary measure of innovation activity in business compared with patents, because of its broader applicability to service industries.

Venture capital

Venture capital is defined as high-risk private equity capital for typically new, innovative or fast-growing unlisted companies. A venture capital investment is usually a short- to medium-term investment with a divestment strategy, with the intended return on investment mainly in the form of capital gains (rather than long-term investment involving regular income streams).

The following describes various stages at which a venture capital vehicle may make investments:

- Earlier stages (includes pre-seed, seed, start-up or early): products are in development, testing or pilot production. Investee companies may not be fully operational and may not yet be generating revenue.

- Expansion (includes early expansion, expansion or late expansion): developed products are in the market, and the investee company has significant revenue growth and may be approaching, or at, profitable operating levels.
- Later stages (includes turnaround, late, buyout or sale): a mature investee company that may require financing for turnarounds (because of flat or declining revenue), consolidation and selling of the business.