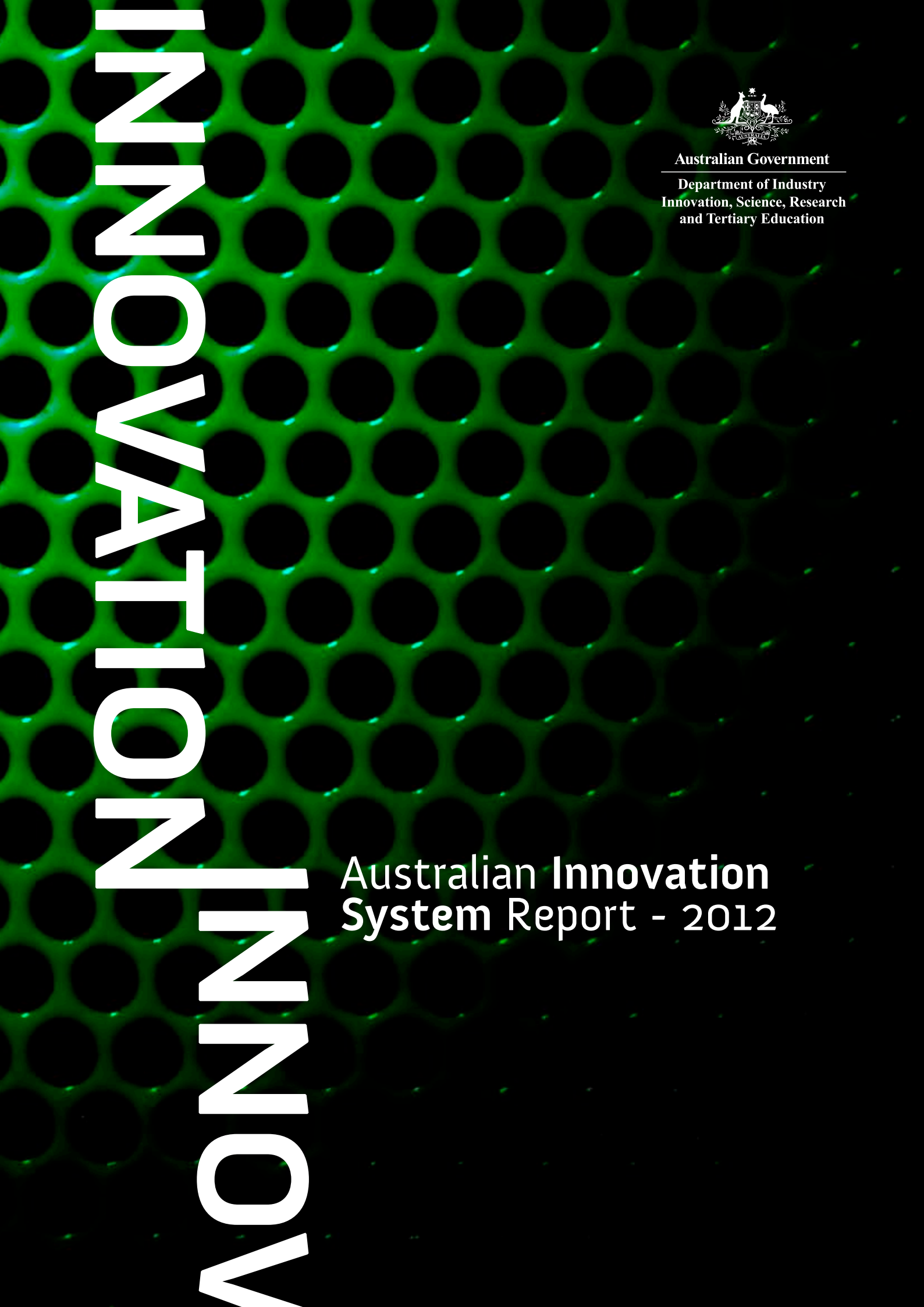

Australian Government
Department of Industry
Innovation, Science, Research
and Tertiary Education

Australian **Innovation System** Report - 2012

INNOVATION

Australian Government

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Innovation, Science, Research
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Australian Innovation System Report 2012

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FOREWORD

Australia needs to innovate if it is to maintain and improve living standards in an increasingly competitive global economy.

Both the resources boom, fuelled by the rise of Asia, and our economic strength are driving structural change in the Australian economy. The terms of trade, the appreciation of the Australian dollar, and high capital investment in the resources sector have all driven a growth in incomes, but have also created pressure on parts of the economy, especially manufacturing. Coinciding with this has been an apparent slowdown in measured productivity across most advanced economies.

With the terms of trade likely to ease over the coming years, we need to boost productivity to ensure that real income growth is maintained. Innovation is fundamentally linked to productivity and competitiveness. Evidence of the link between innovation, productivity and global competitiveness is strong.

Innovation helps create new business opportunities, growth and skilled jobs for the future. The Asian Century offers tremendous opportunities for innovative Australian businesses. The incredible growth in our region and the rise of more middle-class consumers in Asia will mean greater demand for what Australia has to offer – not only in the resources sector but also in areas like energy, water, agriculture, business and financial services, education, tourism, health and high technology manufacturing.

Improving productivity and competitiveness through innovation and skills development is essential. The Government is committed to tackling this challenge head-on.

Tracking the performance of our innovation system is essential in underpinning our efforts. The third annual report on Australia's Innovation System discusses trends in innovation in Australia and where possible benchmarks Australia's performance against other OECD countries. It seeks to offer robust, practical and relevant measures of innovation with a focus on skills and research capacity, business innovation, links and collaboration, and public sector innovation. This report is therefore a valuable resource for decision-makers in industry, government and the research community.

Minister for Industry and Innovation
Minister for Climate Change and Energy Efficiency

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EXECUTIVE SUMMARY

This is the third in the series of annual reports on the performance of Australia's National Innovation System. It discusses trends in innovation in Australia and where possible benchmarks Australia's innovation performance against other Organisation for Economic Co-operation and Development (OECD) countries.

The theme of this year's report is *productivity* which principally drives national prosperity in the long run. Innovation is a tool to facilitate growth in productivity, market diversity, exports and employment. Significant benefits accrue to business and, in aggregate, the economy and society, where a culture of innovation is pursued. Innovation also delivers greater resilience at a business and an economy-wide level, greater ability to handle shocks and changing business and economic conditions.

People often think of innovation as world-first breakthrough technology underpinned by research and development (R&D). Innovation is much broader and more pervasive than this. When an organisation wants to improve something it implements a new direction in its operations: this is innovation. Innovation can have varying degrees of novelty, and the internationally recognised definition of innovation states that the lowest level of novelty is something that is new to a single business. So the adoption or modification of an already existing technology is innovation if it is new to that business. It may not be pushing the boundaries of what is possible for Australia and the world but it can, in aggregate, lift productivity.

The performance of the Australian innovation system

In terms of economic and social prosperity Australia ranks as one of the highest countries in the world. Australia's terms of trade, driven by the recent resources boom, has allowed strong growth in gross national income despite weakening productivity growth. Our weaker productivity growth is an area of concern for the long term. This report argues that long term productivity growth is driven by innovation with innovative businesses nearly twice as likely to report an increase in productivity compared with the previous year when averaged across all business sizes. Like compound interest, the productivity pay-off from business-level innovation and collaboration translates to the entire economy.

Productivity is not the only benefit generated by innovative businesses. Innovation-active businesses are significantly more engaged in the digital economy earning over $144 billion in internet commerce in 2010-11 collectively, more than three times that of non-innovators.[1] Innovation encourages a more connected and skilled economy with greater market diversity and consumer choice. Compared to businesses that don't innovate, innovative Australian businesses are also:

- 42% more likely to report increased profitability;
- Three times more likely to export and eighteen times more likely to increase the number of export markets targeted;
- Four times more likely to increase the range of goods or services offered;
- More than twice as likely to increase employment;
- More than three times more likely to increase training for employees; and
- More than three times more likely to increase social contributions such as community enhancement projects (see Chapters 3 and 4 for more detail on the differences between innovators and non-innovators).[2]

The broad data presented in this report shows an underlying issue with the rate and scale of innovation in Australia. Despite significant growth in R&D expenditure and intellectual property registrations, the proportion of innovation-active businesses has hovered around 41% since 2006-07 and R&D expenditure is dominated by a small number of large businesses in Australia. Unpacking the recent flat trend from 2006-07 onwards, the generally more technological product and process innovations have remained steady or declined, while the less technological managerial, organisational and marketing innovations appear to have increased over the same period. Expenditure on innovation by Australian businesses was estimated to be between $23 billion and $29 billion in 2010-11.[3]

1 ABS (2012) *Selected Characteristics of Australian Business, 2010-11*, cat. no. 8167.0

2 *Ibid*.

3 ABS (2012) *Innovation in Australian business, 2010-11, Appendix 2*, cat. no. 8158.0.

Yet the innovation performance of our businesses is poor by international standards. This is especially stark for large Australian businesses who rank almost last in the OECD on innovation. Small to medium-sized enterprises (SMEs) face higher barriers to innovation and accordingly innovate and collaborate less often. This may create a reduced likelihood of productivity growth from SME innovation despite the relatively more significant pay-off from SME innovation and its share of total economic output at 58% (see Chapter 4). Although Australian SMEs are on average less likely to innovate than large Australian businesses and spend much less on intangible capital such as R&D, they are middle ranked relative to their SME counterparts in other OECD countries.

The evidence presented in this report gives a picture of Australia as a fast-follower country. Australia is not one of the leading countries in terms of competitiveness or high proportions of new-to-the-world innovations. Although investments in innovation (estimated as investments in intangible capital) is growing rapidly, Australia still tends to invest considerably more in adopting and modifying the innovations of others rather than investing in more novel forms of innovation. The more innovative (and competitive) countries have a greater investment in intangibles than physical capital as a share of GDP, at least in later years (Chapter 1). If this investment behaviour represents a positive shift towards an innovation-oriented economy, a considerable gap remains between Australia and other advanced OECD countries.

What is preventing Australian businesses from investing in innovation that could bring about a reorganisation of production sufficient to significantly increase productivity? The proportion of Australian businesses reporting one or more barriers to innovation increased to 45% between 2005-06 and 2010-11. Limited access to either skilled people or additional funds remain the two most common perceived external barriers to innovation.

An educated and skilled workforce is essential for successful innovation because such a workforce is more likely to be able to generate and implement new ideas and to adapt to new technological and organisational change originating from elsewhere. *Lack of skilled people* has been the highest single reported barrier to innovation in Australian businesses in recent years. This barrier to innovation is declining as the working population becomes better educated and more skilled. This report shows that innovative businesses encourage a virtuous cycle for skills, employment and labour market flexibility. Innovative businesses are significantly more likely to increase employment, training and more flexible working arrangements than non-innovators. Innovative businesses, particularly small ones, are also much more likely to be profitable and productive as a result of innovation leading to further demand for skilled workers.

Innovation is an *endogenous* phenomenon. In other words, it doesn't just spontaneously happen for the benefit of all. Innovation occurs because managers of organisations make internal strategic decisions to mobilise resources, capabilities and creativity to make it happen. The data shown in this report suggests that Australian business management capability and innovation culture is poor by international standards and may be a factor in the current productivity slowdown. Taken with the productivity pay-offs of innovation and collaboration and the relatively poor innovation culture of Australian businesses described in this report, creating a culture of innovation in the management of Australian businesses, particularly SMEs, should lift productivity.

Business framework conditions that influence innovation activity have worsened on a number of indicators in recent years, particularly around financing of innovation. The percentage of Australian businesses seeking finance for innovation has declined by 40% since 2006-07. Venture capital and later stage private equity investment in Australia has declined substantially over the same period. Despite these trends, Australia's framework conditions remain moderately to highly ranked internationally.

The research sector has a fundamental role in lifting innovation and hence productivity by generating new knowledge and absorbing knowledge from around the world. The performance of the research sector is significantly improving in terms of both quality and quantity of research output given our moderate to high investments in this sector. R&D by the research sector is highly focussed on economic development.4 If the socio-economic objectives of Defence and Health are included then more than half of the research sector's expenditure on R&D is aimed at the development of major domestic industries. The proportion of higher education sector R&D expenditure in these three areas has increased from 43% to 60% between 1992 and 2010. The proportion of government research sector expenditure on health, defence and economic development declined from 76% in 1992-93 to 64% in 2008-09, due to a reduction in expenditure on economic development.

4 Based on socio-economic objective classification of R&D.

The report shows that there are compounding productivity benefits accruing to businesses that pursue a culture of both innovation *and* collaboration. This is the case for most business performance measures. Collaboration is correlated with the capacity of innovation-active businesses to offer a wider range of products and services to the market and an increased expenditure on information technology (Chart 5.2). Compared to innovative businesses that don't collaborate, innovative and collaborative Australian businesses are:

- 23% more likely to report increased productivity;
- 24% more likely to report increased profitability;
- More than three times more likely to increase the number of export markets targeted;
- 48% more likely to increase the range of goods or services offered;
- 24% more likely to increase employment; and
- 34% more likely to increase training for employees.[5]

Despite the significant benefits of collaboration, Australian businesses of all sizes remain poor collaborators by international standards. Collaboration of all types is poor, including research-industry collaboration and international collaboration.

Performance against the Australian Government's targets

The Australian Government has set a number of targets to measure progress against its ten year innovation priorities (see the table below).

The global context of this third report is a complex one. Widespread international concerns exist over the stability of international financial markets, particularly among OECD countries, and these are counterposed against the rising economic power of Asian economies and the spill-over benefits to Australia. In Australia, the variously used concept of a "two-speed" or "patchwork" economy has come to describe the differentials between the high growth resource and low growth non-resource sectors. As well, the high Australian dollar has impacted performance of trade-exposed industries.

Compared to baseline years, improvements against the government's targets are mixed. The number of research areas performing above world average citation rates has remained steady and high at 19 out of the 22 research fields considered. For example, the number of students completing higher degrees by research in Australia increased by 3.2% between 2008 and 2010. In terms of businesses investing in R&D a substantial increase is notable, with the number of businesses registering for the R&D Tax Concession increasing 15.3% from 7,906 in 2007-08 to 9,118 in 2010-11.[6] Businesses are considered *innovation-active* if they have introduced an innovation, are in the process of developing an innovation (but not yet introduced it to the market) or have abandoned an innovation project. The proportion of innovation-active businesses has oscillated around 41% in the last five years. The recent negative change is within this variation.

The proportion of innovation-active businesses collaborating with universities or other research institutions has declined by 21% to 9.5 percentage points since 2006-07. Collaboration data is the most volatile of the target indicators and this volatility reflects both the reactive or *ad hoc* nature of collaboration as well as how a small change in the already low proportions of businesses collaborating can produce large swings in the data from year to year. Most OECD countries show large variations from year to year, but have higher proportions of collaboration on innovation with the research sector. Australian businesses tend to collaborate more with customers, suppliers and even competitors. Broader business collaboration indicators (with any partner) have increased since the 2006-07 baseline year.

International research collaboration shows mixed results. The share of all higher education research financed from abroad in 2010 decreased by 24% from the baseline year of 2006 to 2.18 percentage points, despite an increase in nominal terms ($179 million). The number of formal collaborative agreements with overseas institutions has increased by 46%. The extent of international collaboration in the research sector continues to increase strongly and dominate high quality research (see Chapter 2).

5 ABS (2011) Data analysis commissioned by DIISRTE.

6 Registration data for the 2010-11 year as at 30 June 2012. This data is incomplete for the 2010-11 year as registrations continue to be received after this date.

Target	Indicator	Latest figure	Latest reference period	% Change from baseline	Baseline reference period
Target 1: Increase the number of research groups performing at world-class levels, as measured by international performance benchmarks	Number of fields with higher than world average citation rate by field.	19 out of 22	2006-2010	No change[r]	2004-2008
Target 2: Significantly increase the number of students completing higher degrees by research over the next decade.	Number of students completing higher degree by research in Australia.	7,401	2010	3.2%	2008
Target 3: Increase in the number of businesses investing in R&D.	Number of businesses registered for the R&D Tax Concession.	9,118[a]	2010-11	15.3%	2007-08
Target 4: 25% increase in the proportion of businesses engaging in innovation over the next decade.	Proportion of innovation-active businesses in Australia.	39.1%	2010-11	-12.9%	2007-08
Target 5: Double the level of collaboration between Australian businesses, universities and publicly-funded research agencies over the next decade.	Proportion of innovation active businesses collaborating with universities or other research institutions excluding commercial*	9.5%	2008-09	-20.7%	2006-07
Target 6: Increasing international collaboration in research by Australian universities.	Number of formal agreements on academic/research collaboration between Australian universities and overseas institutions.	5,086	2011	45.6%	2009
	Share of HERD financed abroad	2.18%	2010	-24.4%	2006

Note: {r} baseline has been revised according to the latest available data. a Registration data for the 2010-11 year (as at 30 June 2012) are incomplete; further applications for the 2010-11 income year will continue to be received up to 31 October 2012 from companies with non-standard income period balance dates. * Replacement indicator, no further data available for previous indicator

An online compendium of government innovation program updates accompanies this report and is further described in Appendix 1 of this report. The compendium outlines more than two hundred new or significant changes to policies designed to foster innovation across Australia. These programs address or complement the Australian Government's national innovation priorities. As the large number of new programs and policy updates suggest, there is a considerable level of activity in the area of government support for innovation. Areas of common activity across Australian, State and Territory governments include supporting innovation through:

- Business management and other skills development;
- Health and health related issues and services;
- Environmental issues such as clean technology;
- Technology and trade;
- Partnerships and collaborations; and
- Network and precinct creation and building.

INTRODUCTION

The objective and structure of this report

The Australian Innovation System report is a commitment of the Australian Government[7] to monitor the performance of our innovation system at a national level. 'Performance' is measured against targets set for the government's seven National Innovation Priorities and by comparing our system with the performance of other national innovation systems around the world. This report is the third in the series and builds on the data and insights from previous reports and explores different or new facets of the innovation system.

Using the most recent available data, this report shows that innovation delivers better productivity, export and employment growth outcomes (to name a few) for businesses and explores the positive relationship between innovation and productivity at a macro-economic level (Chapter 1). It outlines how research (Chapter 2), skills development and labour market flexibility (Chapter 3) underpin our capacity to innovate, the importance of business culture in driving innovation, particularly business model innovation (Chapter 4), and shows that collaboration gives businesses an edge over others on almost all measured performance criteria (Chapter 5). The report examines how innovation is a tool for not only economic benefits but also social change (Chapter 6) and concludes with a discussion of opportunities or challenges facing the Australian Innovation System (Chapter 7).

The report also highlights recent achievements and actions by individuals and organisations in the national innovation system in the form of features and case studies (found throughout the report) or recent government innovation policy developments (Appendix 1). For a complete picture of government innovation initiatives the reader is encouraged to visit the www.innovation.gov.au, www.business.gov.au, www.ausindustry.gov.au, www.arc.gov.au or www.grantslink.gov.au websites. A compendium of recent updates to government innovation policies can be found online at www.innovation.gov.au/innovationreport/2012/compendium.

Concepts, definitions and methodology

Where possible, this report's concepts, definitions and methodology are based on the Australian Government's *Innovation Metrics Framework Report* and the concept of an innovation system introduced in previous reports.[8] A key challenge to describing the innovation system is the timeliness and quality of quantitative data. This report although released in 2012 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 features. Data in this report is current as of September 2012.

Where possible all indicators are provided back to 2006 (2006-07). Reference or 'baseline' years are taken from the 2010 report, and for new indicators the baseline year is 2007 (2007-08) or, if data is collected every two years, the previous year 2006-07. Most Australian innovation data is compiled according to fiscal years, while OECD data is compiled according to calendar years. As part of a systems approach to measuring innovation, international comparisons for each indicator are presented where possible. Unlike Australia, many other Organisation for Economic Co-operation and Development (OECD) countries' national survey instruments for measuring business innovation are not mandatory, leading to a variable coverage and low response rates.[9] 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 to other OECD countries, although analysis by the Australian Bureau of Statistics suggests this does not have a significant effect. Other measures of education and R&D investment are more comparable. It has not been possible to adjust for industrial structure for every indicator and every sector. Further analysis is required to consider how differences in innovation between Australia and other OECD countries might be explained by differences in industrial structure.

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7 DIISR (2009) *Powering Ideas: An Innovation Agenda for the 21st Century*, Commonwealth of Australia, Canberra.

8 DIISR (2009) *Innovation Metrics Framework*, Department of Innovation, Industry, Science and Research, Canberra. See further discussion in DIISR (2011) *Australian Innovation System Report – 2011*, Department of Innovation, Industry, Science and Research, Canberra, pp.11-13.

9 OECD (2009) *Innovation in Firms: A Microeconomic Perspective,* OECD, Paris.

What is innovation?

Innovation has many dimensions that make defining it a complex issue.[10] There are a number of typologies and scales to consider. An innovation could be: new to the business or new to the world; a small but significant tweak to a process; a radical transformation of an entire global supply chain, a new service or business model; and, it might not involve technology at all. Lastly, the intent or outcome of the innovation can be singular or multiple and varies dramatically often in unforeseen ways. Despite this complexity it is necessary to adopt an internationally recognised definition of innovation if we are to compare Australia with other countries.

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. [11]

This definition recognises that innovation is more than just the generation of new ideas through expenditure on R&D; it is also about execution: bringing an idea to a market or another material outcome that generates an impact on our economy, our society, our environment. This definition is also business-focussed which means most of our quantitative measures detailed in this report relate to business innovation. The many activities that underpin this definition[12] create boundaries. Although these definitional boundaries allow us to usefully compare ourselves with other countries, they also create the concept of 'hidden innovation' where other ways of innovating, such as what happens in social innovation or public sector innovation might remain unrecognised. This situation is changing and Chapter 6 of this report details the many efforts to uncover hidden innovation performance in these areas.

What is an innovation system?

At its most basic level, an innovation system is about people. It is about the organisations, rules, cultures and interactions these people create and how these things are used to generate and exploit knowledge and ideas. All of these aspects of an innovation system evolve over time to give it unique characteristics. Innovation systems evolve laws, regulations and cultures at many levels: national, regional, sectoral and even technological. Although this report mostly compares Australia's national innovation system with others across the OECD, data on sectoral and regional variations are also explored. For the purposes of this report we adopt the following definition.

An innovation system is an open network of organisations both interacting with each other and operating within framework conditions that regulate their activities and interactions. These 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.[13]

A systems approach to innovation also recognises the important role of organisations other than businesses: the education, training and research sectors generate and exploit knowledge; the public sector regulates innovation activities; and, the community sector innovates to improve societal welfare and protect the environment. These activities are not exclusive, offering opportunities for pooling resources and working together towards a common goal. This 'collaboration' allows our national innovation system to be more than the sum of its parts.

Why should we innovate?

Innovation is synonymous with change and a high capacity to deal with change allows us to be resilient and prosper. We therefore need a resilient innovation system that coordinates and shapes itself to address immediate or future challenges and opportunities.[14] To create a high performing innovation system we need to engender a culture of innovation and resilience in all participants.[15] From the previous report and an extensive body of literature on the subject, innovation is considered a proactive tool for dealing with change for any individual or organisation. Ninety two per cent of senior executives surveyed by the GE Global innovation barometer agreed that innovation is the main lever to create a more competitive economy and 84% believed that 21st Century innovations will be those that bring value to society as a whole and not only to individual consumers or citizens.[16] Ninety one per cent of Australian businesses report a benefit from innovation and this number can be as high as 97.6% for large Australian businesses. These benefits include increased revenue, reduction in costs, gaining a competitive advantage and improved customer service.[17] The benefits of innovation to business and society are further detailed in the following chapters.

10 See further discussion in DIISR (2011) *Australian Innovation System Report – 2011*, Department of Industry, Innovation, Science, Research and Tertiary Education, Canberra, p.7.

11 OECD (2005) *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data,* 3rd edition, OECD and European Commission, Paris.

12 DIISR (2011) *Australian Innovation System Report – 2011*, Department of Industry, Innovation, Science, Research and Tertiary Education, Canberra, p.7.

13 *Framework conditions,* also known as institutions or rules of the game, comprise a set of established practices, rules or laws that regulate the interactions between individuals and organisations.

14 For a broader discussion of the innovation system refer to the DIISR (2011) *Australian Innovation System Report – 2011*, Department of Industry, Innovation, Science, Research and Tertiary Education, Canberra, pp.11-29.

15 The concept of business innovation culture is further explored in Chapter 3.

16 GE Global Innovation Barometer 2012 http://www.ge.com/innovationbarometer/key_findings.html [Accessed 13 June 2012].

17 ABS (2012) *Innovation in Australian Business,* 2010-11, cat. no. 8158.0.

CHAPTER 1

Innovation drives productivity

Australia's prosperity

Finding ways of working smarter and with less impact on the world's ecosystems through the productive management of human and natural resources is a top priority for Australia. To date our creativity, drive and resource endowments have enabled Australia to prosper. Table 1.1 provides an overview of Australia's prosperity and shows that Australia generally performs well. The Legatum Institute's Prosperity Index[18] ranks Australia third overall in the world behind Norway and Denmark.

Australia compares well on indicators of social and economic prosperity with other OECD countries ranking 6th amongst OECD countries in gross domestic product (GDP) per capita (Table 1.1). Our GDP per capita grew by 40% between 2001 and 2010 to $US 40,790 (PPP).[19] While Australia's GDP per hour worked has dropped from 11th in 2008 to 14th in 2011, ABS figures reveal that the number of hours worked has increased steadily from 1994 to 2011[20] to the extent that the Australian economy is now considered to be at full employment. In terms of quality of life indicators, Australia's performance across two indicators is divergent (Table 1.1). It is important to note that prosperity and well-being is multi-dimensional and Australia is not always ranked highly. The Human Development Index is a comparative measure of well being incorporating life expectancy, literacy, education, and standards of living of a country. Australia's high ranking in the Human Development Index remains unchanged, indicating that Australia has the second highest standard of living in the world. However, Australia also has the fourth highest percentage of employees working more than 50 hours per week and the sixth lowest amount of time devoted to leisure and personal care.[21] In terms of environmental performance, Australia appears to be one of the lowest ranked countries in the developed world particularly on 'climate change', because of its high per capita emissions of carbon dioxide, and 'forests'. The Australian Government has recently introduced a price on carbon pollution and the Clean Energy Future Plan in recognition of this issue.[22]

Productivity and prosperity are intertwined

Productivity is a measure of how efficiently a society employs finite resources such as land, labour and equipment to make goods and services. As such, it is a ratio of economic outputs to inputs.[23] The importance of productivity lies in its role as the main factor contributing to long term income growth and hence to material standards of living and reallocation of taxes for social and environmental aims.[24] Gross Domestic Product (GDP) per capita[25] can generally be lifted by increasing the number of hours we work (labour utilisation), or by improving the efficiency with which we work (labour productivity).[26] Australia's working population is projected to shrink in the next 50 years[27] and there is a limit to how much that population can a) participate in the workforce and once participating b) work longer hours and c) keep moving where the work is.[28] Therefore, sustained growth in material living standards will have to come mainly from labour productivity increases in the long term.[29]

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18 Legatum Prosperity Index (2012) http://www.prosperity.com/summary.aspx, Accessed [13 August 2012]

19 *OECD Factbook Statistics* (OECD.Stat).

20 ABS (2011) *Experimental Estimates of Industry Multifactor Productivity,* Australia. cat. no. 5260.0.

21 OECD (2011) *OECD Better Life Initiative: Compendium of OECD well-being indicators*, http://www.oecd.org/dataoecd/4/31/47917288.pdf, Accessed [20 August 2012].

22 www.cleanenergyfuture.gov.au/clean-energy-future/our-plan/ Accessed [31 October 2012].

23 Labour productivity measures the amount of output produced per unit of labour input. Multifactor productivity measures the amount of output for a given amount of combined inputs.

24 D'Arcy P & Gustafsson L (2012) Australia's productivity performance and real incomes, *Reserve Bank of Australia Bulletin,* June quarter.

25 Our most commonly used indicator of a country's standard of living.

26 GDP/capita = hours/capita (labour utilisation) x GDP/hour (productivity).

27 Australian Government (2010) *Australia to 2050: future challenges*, Intergenerational Report 2010, Treasury, Canberra.

28 Australian Government (2010) *Australia to 2050: Future Challenges, op.cit.;* Hugo, G. et al (2010) *Report of the Advisory Panel on Demographic Change and Liveability,* Final Report to the Minister for Sustainability, Environment, Water, Population and Communities, the Hon. Tony Burke, MP, December, p.61.

29 Australian Government (2010) *Australia to 2050: Future Challenges, op.cit.*

Table 1.1: Australia's performance in innovation outcomes against other OECD countries

Indicators	2006	2007	2008	2009	2010	2011	2012	OECD average (latest year)	OECD top five average (latest year)	Gap from the top 5 OECD performers (latest year)	Ranking against OECD countries (latest year)	Change from baseline year to latest year (Baseline in bold)
Share of high and medium-high technology manufacturing in GDP[1]	2.6	**2.6**	2.3	2.3	2.1	-	-	n/a	n/a	n/a	n/a	-18%
Exports in goods as a % of GDP[2][r][a]	15.3	**14.4**	17.7	15.3	16.5	17.8	-	37.8	73.0	76%	28th	23%
Exports in services as a % of GDP[2][r][a]	4.0	**4.1**	4.6	4.1	4.0	4.0	-	12.1	35.0	89%	26th	-2.5%
Exports in commodities as a % of GDP[2][r][b]	-	14.3	**17.8**	15.2	16.5	16.1	-	38.7	82.3	80%	25th	-9.3%
Exports in raw commodities as a % of GDP[2][r][b]	-	5.9	**9.6**	8.1	9.7	10.0	-	3.8	10.1	No Gap	3rd	4.5%
GDP per capita relative to the USA (USA = 100)[2][r][c]	83	83	**84**	88	87	-	-	72	111	22%	6th	3.5%
GDP per hour worked (USA = 100)[2][r]	-	-	**82**	83	79	81	-	73	115	30%	14th	-1.8%
World ranking by the Global Competitiveness Index[3]	19th	**19th**	18th	15th	16th	20th	20th	n/a	n/a	n/a	15th	n/a
World ranking by the Human Development Index[4]	2nd	**2nd**	2nd	2nd	2nd	2nd	-	n/a	n/a	No Gap	2nd	n/a
World ranking by the Environmental Performance Index[5][r]	42nd	**42nd**	47th	48th	48th	-	48th	n/a	n/a	n/a	28th	n/a

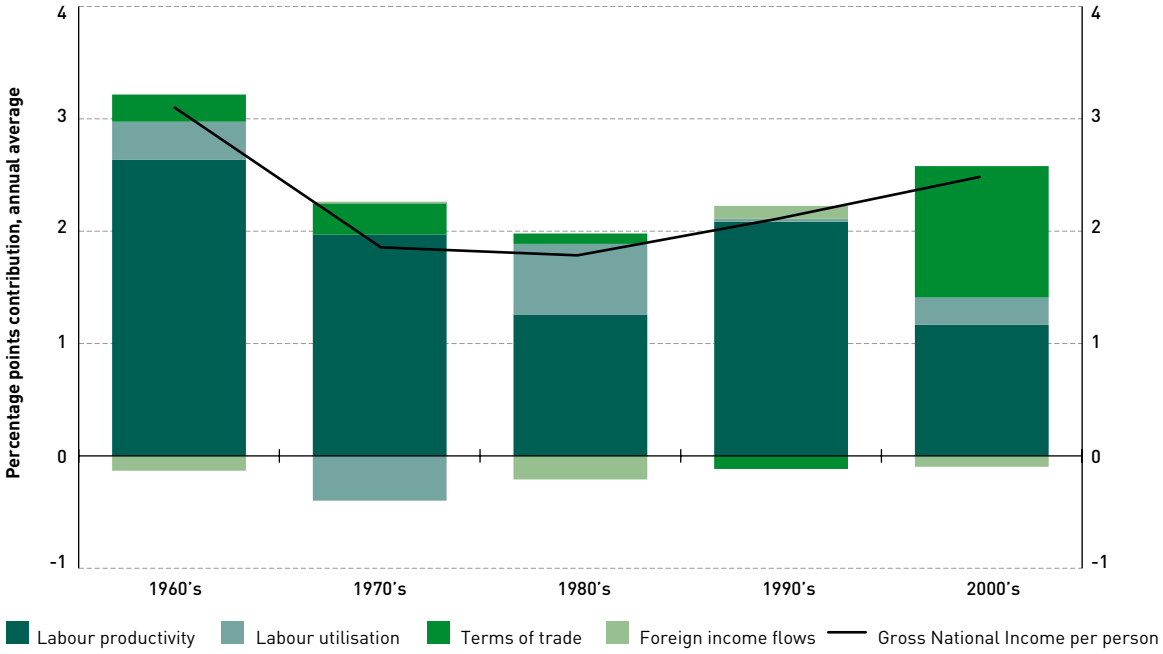
Sources:

1 ABS (2011) *Experimental Estimates for the Manufacturing Industry*, cat. no. 8159.0, 2006-07, 2007-08, 2008-09, 2009-10. ABS (2012) *Australian Industry, 2010-11,* cat. no. 8155.0,.
2 *OECD Factbook Statistics* (OECD.Stat),
3 World Economic Forum, *The Global Competitiveness Report 2007-08 to 2012-13.*
4 Human Development Index (HDI) value: HDRO calculations based on data from UNDESA (2011), Barro and Lee (2010), UNESCO Institute for Statistics (2011), World Bank (2011a) and IMF (2011).
5 Yale University and Columbia University, in collaboration with the World Economic Forum and the Joint Research Centre for the European Commission, Environment Performance Index 2012

Notes: (a) The figures are derived by DIISRTE from the OECD source based on data on exports in goods and services and GDP in billion US dollars, current process and PPPs. (b) 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. (c) The measure used is in per head, US $, constant prices, constant PPPs, OECD base year [r] The data may have been revised according to the latest available data. [nd] No new data. [n/a] not available. [-] not applicable. OECD rankings are performed on those OECD countries for which data is available. Individual data availability may vary between indicators. Rankings from previous reports have been revised and may vary as a result.

Chart 1.1 shows the key role of labour productivity in income growth over the last five decades and the recent decline in the contribution of labour productivity throughout the 2000s, a common trend across the OECD. It also shows that unlike many other OECD countries[30], Australia's favourable terms of trade, driven by the resources boom, have made imports cheaper and propped up growth in gross national income over the same period. However, growth fuelled by demand for natural resources is not necessarily sustainable and therefore carries risk.[31] A number of economic analysts[32] have predicted a slowdown in the resources boom and hence our favourable terms of trade. Australia cannot control commodity prices, global demand for resources or stronger competition from Brazil, India and Africa. So, what can we do to maintain growth in our standard of living when the boom eventually subsides? Notwithstanding the debate about income distribution (national output is outstripping real wages growth) many economists argue that lifting Australia's productivity is the long term answer to this question.

Chart 1.1: Contributions to growth in average incomes by decade



Source: Treasury calculations based on ABS cat. no. 5206.0, 6202.0 and unpublished ABS data.
Note: Data for the 2000s are for the eleven years to 2010-11. The chart is derived from calculations of real GNI, real Gross Domestic Income (GDI) and real Gross Domestic Product (GDP), based on the decomposition in logarithms of (GNI/GDI).(GDI/GDP).(GDP/Hours worked).(Hours worked/Population).

30 Wei H & Zhao P (2012) *The Industry Sources of Australia's Productivity Slowdown,* Paper to 2nd World KLEMS conference, Harvard University, 9-10 August.

31 Taylor C, Bradley C, Dobbs R, Thompson F & Clifton D (2012) *Beyond the boom: Australia's productivity imperative,* McKinsey Global Institute Report, August.

32 Dolman B & Gruen D (2012) *Productivity and structural change,* paper presented to the 41st Australian Conference of Economists, Melbourne, 10 July; Deloitte Access Economics (2012) *Business Outlook - June 2012* [Accessed 23 July 2012]; D'Arcy P & Gustafsson L (2012) .Australia's productivity performance and real incomes, *Reserve Bank of Australia Bulletin*, June quarter; Turner A (2012) *Blue Sky Mining: Building Australia's Next Billion Dollar Industries*, Amazon Digital Services.

The recent decline in measured labour productivity growth, while most significant for the mining, utility and agriculture sectors[33], has occurred across all sectors. It has imposed not only a cost on the domestic economy, in part through higher prices of non-tradeable goods and services, but also increased inflationary pressure.[34]

Major strategies for improving labour productivity include:

- adopting technological innovations through capital investment in machinery and equipment[35,36] (physical or tangible capital deepening);
- improving skills;
- creating a better environment for work;
- implementing new or significant improvements to products and processes;
- creating and adapting knowledge such as through R&D;
- commercialisation; and,
- improving the way we organise and manage our work i.e. business model innovation (human and/or intangible capital deepening).[37]

The previous Australian Innovation System report argued that, in the medium to long term these investments in innovation (both tangible and intangible) and their spill-overs can explain up to around 90% of labour productivity growth.[38]

While appropriate investments in additional physical capital or labour will raise or maintain labour productivity growth it has a transient payoff.[39] Physical capital will deteriorate and the extra hour of work is soon gone.[40] At a certain point, investing in more of the same has lower impact. The business transformations and new capabilities behind Australia's productivity gains in the 1990s came from the use of enabling technologies like information and communication technology, improved management competencies, and regulatory reforms.[41] It was not generally the result of greater capital investment to replace labour.[42] So in the long term we need to look to the other sources of productivity growth mentioned above, which for the most part come down to lifting management quality, other skills capability building, and all forms of innovation.[43,44,45]

33 Productivity Commission (2009) *Submission to the House of Representatives Standing Committee on Economics: Inquiry into Raising the Level of Productivity Growth in Australia,* September.

34 D'Arcy P & Gustafsson L (2012) Australia's productivity performance and real incomes, *Reserve Bank of Australia Bulletin,* June quarter.

35 *Ibid*.

36 Arundel A & O'Brien K (2010) Innovation metrics for Australia, In, *Innovation Metrics Framework,* Department of Innovation, Industry, Science and Research, Canberra.

37 Webster E (2012) *Intergen+10: What about productivity?* Paper presented at the 10th anniversary of the Treasury's Intergenerational Report, Shine Dome, Canberra, 11 May; Taylor C, Bradley C, Dobbs R, Thompson F & Clifton D (2012) *Beyond the boom: Australia's productivity imperative,* McKinsey Global Institute Report, August 2012.

38 DIISR (2011) *Australian Innovation System Report – 2011*, Department of Industry, Innovation, Science, Research and Tertiary Education, Canberra, p.9.

39 Robertson PE (2009) Productivity, innovation & economic growth, in *Innovation Metrics Framework,* Department of Innovation, Industry, Science and Research, Canberra Australia.

40 Productivity Commission (2009) *Submission to the House of Representatives Standing Committee on Economics: Inquiry into Raising the Level of Productivity Growth in Australia,* September.

41 Dolman B and Gruen D (2012) *Productivity and structural change,* paper presented to the 41st Australian Conference of Economists, Melbourne, 10 July.

42 Hughes A & Grinevich V (2007) *The Contribution of Services and Other Sectors to Australian Productivity Growth, 1980-2004,* Australian Business Foundation, Sydney; Productivity Commission (2009) *Submission to the House of Representatives Standing Committee on Economics: Inquiry into Raising the Level of Productivity Growth in Australia,* September.

43 OECD (2010) *The OECD innovation strategy: Getting a head start on tomorrow,* OECD, Paris; D'Arcy P & Gustafsson L (2012) Australia's productivity performance and real incomes, *Reserve Bank of Australia Bulletin, June quarter 2012; Smith K & West J (2007) Innovation policy, productivity, and the reform agenda in Australia: A framework for analysis,* Council of Australian Governments report; Solow R (1957) Technical change and the aggregate production function, *The Review of Economics and Statistics* 39: 312-320; Webster E (2012) *Intergen+10: What about productivity?* Paper presented at the 10th anniversary of the Treasury's Intergenerational Report, Shine Dome, Canberra, 11 May.

44 Robertson PE (2009) Productivity, innovation & economic growth, in *Innovation Metrics Framework,* Department of Innovation, Industry, Science and Research, Canberra.

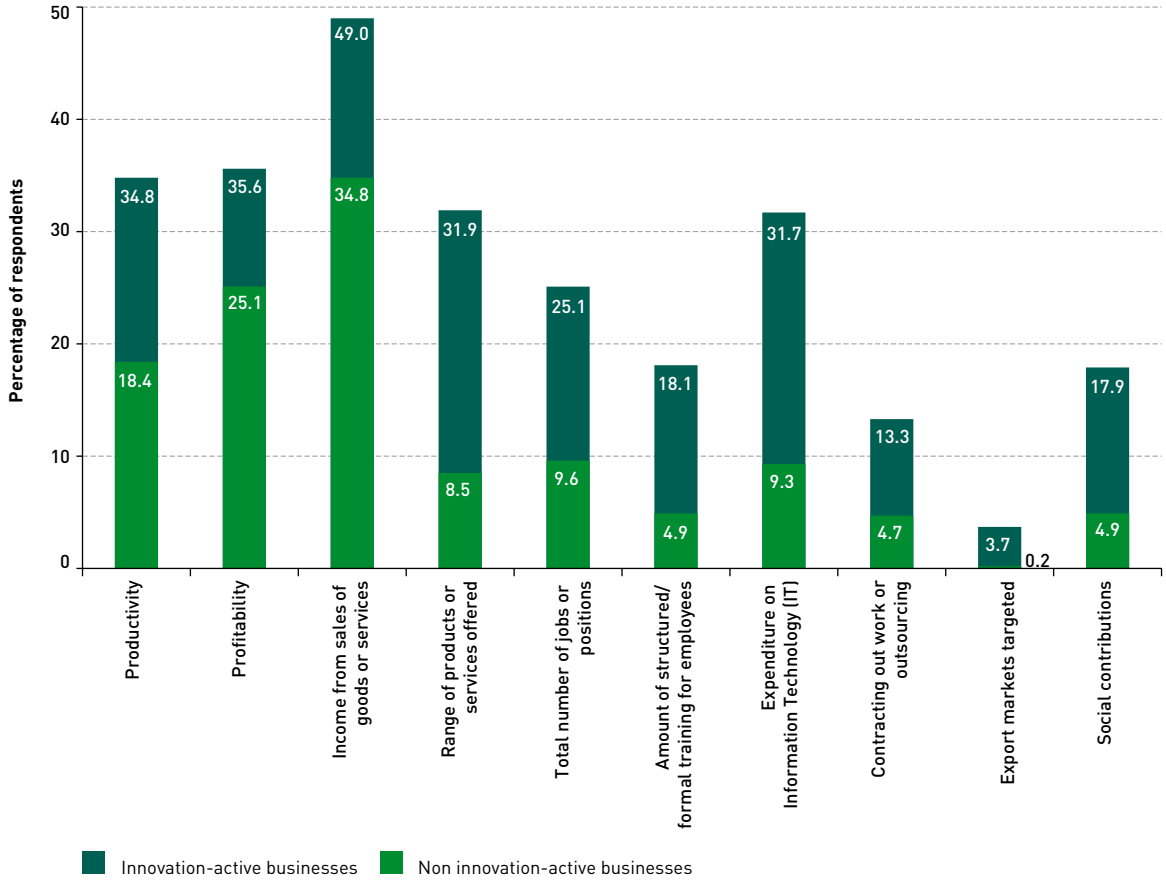
45 OECD (2010) *The OECD Innovation Strategy: Getting a Head Start on Tomorrow,* OECD, Paris.

Innovation delivers productivity, but not only productivity

Innovation can increase productivity through more efficient services and production processes, more effective workplace organisation and by opening up new markets. Innovative businesses boost productivity by investing in problem-solving capabilities, collaborating with customers, suppliers and competitors, adapting existing technologies and processes to new uses, and creating solutions to meet customers' needs.[46] It's hard to imagine areas of life untouched by innovation.

Official data shows the stark benefits of business innovation at a business level (Chart 1.2). Innovative businesses are almost twice as likely to report an increase in productivity compared with the previous year, averaged across all business sizes (Chapter 4 shows that this difference is much smaller for large businesses). This data shows that boosting productivity across the entire economy requires more business innovation. Like compound interest, the productivity pay-off from business-level innovation translates to the entire economy.

Chart 1.2: Increases in business performance and activities compared to previous year, by innovation status, 2010-11



Source: ABS (2012) *Selected Characteristics of Australian Business, 2010-11*, cat. no. 8167.0

46 Australian Business Foundation (2010) *Innovation and productivity,* abfoundation.com.au [Accessed 12 May 2012].

Productivity is not the only benefit generated by innovative businesses. Innovation-active businesses are also significantly more engaged in the digital economy, earning over $144 billion in internet commerce in 2010-11 collectively, more than three times that of non-innovators.[47] Innovation encourages a more connected and skilled economy with greater market diversity and consumer choice. Compared to Australian businesses that don't innovate, innovative Australian businesses are also:

- 42% more likely to report increased profitability;
- Three times more likely to export and eighteen times more likely to increase the number of export markets targeted;
- Four times more likely to increase the range of goods or services offered;
- More than twice as likely to increase employment;
- More than three times more likely to increase training for employees; and
- More than three times more likely to increase social contributions such as community enhancement projects (see Chapters 3 and 4 for more detail on the differences between innovators and non-innovators).[48]

The higher social contributions of innovative businesses raises the point that, similar to higher productivity[49], innovation is also a tool to address social inclusion issues, such as unequal wealth distribution and provision of public health care (see Chapter 6). Additionally, there are issues around the physical limits to growth. How can our economic growth and prosperity continue through consumption of finite resources?[50] It is also argued that innovation in all its forms is fundamental to the decoupling of economic growth from resource depletion and pollution.[51]

Significant innovation to achieve environmental and other social benefits may be occurring across Australia that is not yet reflected in measurements of industry output. It may be the case that innovative efforts to help conserve or repair ecosystem services may act to decrease productivity[52] or may be simply allowing economic growth to be sustained in the long term without any short term gain. This is an area where large businesses are contributing more effort (see Chapter 4; Chart 4.1).

Innovation and the productivity slowdown

Decomposition of the labour productivity slowdown in the 2000s by the Reserve Bank of Australia and the Treasury shows that the slowdown was due to a broad-based fall in multifactor productivity (MFP) growth rather than reduced capital investment.[53] MFP is an indicator of the productive efficiency of the economy as it captures how well capital and labour inputs combine to produce a given level of output. In other words MFP is the result of business level improvements in areas such as skills, technology, management practices, and benefits from the free uptake of innovation developed elsewhere (so-called knowledge spill-overs[54]).[55] Chart 1.3 shows the MFP decline by comparing the last two complete productivity cycles. Australia's average annual MFP growth rate was ranked 12th largest in the OECD between 1985 to 1994, improving to 2nd in the OECD in 1994-1999 period and then declining to 14th in the 1999-2007 period.[56]

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47 ABS (2012) *Selected Characteristics of Australian Business,* 2010-11, cat. no. 8167.0.

48 *Ibid*.

49 Eslake S & Walsh M (2011) *Australia's Productivity Challenge,* Grattan Institute Report No. 2011-1 February.

50 OECD (2011) *Towards Green Growth,* OECD, Paris; Meadows DH, Randers J & Meadows DL (2004) *Limits to Growth: The 30 Year Update,* Chelsea Green, USA; United Nations Environment Programme (2011) *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication,* United Nations, New York.

51 *Ibid*.

52 See Eslake S & Walsh M (2011), *op.cit.,*for a discussion of the difficulties in measuring productivity.

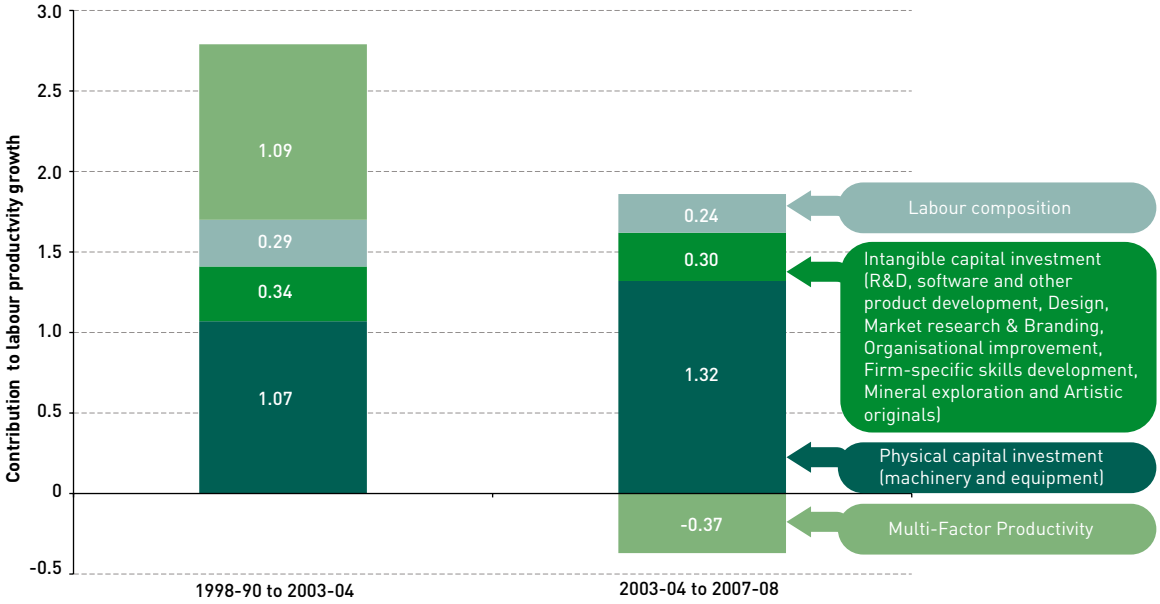
53 Parham D (2012) *Australia's Productivity Growth Slump: Signs of Crisis, Adjustment or Both?* Productivity Commission Visiting Researcher Paper, April; D'Arcy P & Gustafsson L (2012) Australia's productivity performance and real incomes, *Reserve Bank of Australia Bulletin,* June quarter; Dolman B and Gruen D (2012) *Productivity and structural change,* paper presented to the 41st Australian Conference of Economists, Melbourne, 10 July.

54 A knowledge spill-over is an exchange of ideas where the benefits of innovations developed by innovators are used by others that don't invest in innovation themselves.

55 There are data and methodological challenges in the MFP measurement and the computation of the relationship between innovation and MFP. MFP has methodological difficulties in taking into account quantitatively important economic issues such as increasing resources depletion, quality improvement and mitigation of climate change; National Endowment for Science, Technology and the Arts (2009) *The Innovation Index: Measuring the UK's investment in innovation and its effects,* NESTA London, UK; van Leeuwen G, Mohnen P, Polder M & Raymond W (2009) *Productivity effects of innovation modes,* Statistics Netherlands Working Paper.

56 Productivity Commission (2009) *Submission to the House of Representatives Standing Committee on Economics: Inquiry into Raising the Level of Productivity Growth in Australia,* September.

Chart 1.3: Breakdown of contributions to labour productivity growth, market sector (per cent per year) for productivity cycles 1998-99 to 2003-04 and 2003-04 to 2007-08



Source: Melbourne Institute of Applied Economic and Social Research (2012), figures commissioned by the DIISRTE.

Australia's measured MFP, or productive efficiency, has declined in recent years. It has been sometimes argued that, based on significant growth in expenditure on R&D over the last decade, innovation does not appear to have played a role in reversing the current productivity slowdown.[57] For one, expenditure on R&D is an imperfect proxy for innovation. In Australia, the propensity to introduce a new-to-the-market product innovation is similar whether business undertake R&D or not.[58] Additionally, the majority of expenditure on R&D is highly concentrated in large Australian businesses, which accounts for only 42% of Australia's output (in terms of gross value added), and in sectors such as Mining, Manufacturing and Financial and Insurance Services.[59] The total number of companies registered for the R&D Tax Concession was 9,118[60] in 2010-11, a small fraction of the 764,000 innovative businesses in Australia.

The broad data hints at an underlying issue with the rate and scale of innovation in Australia suggesting that poor innovation performance may have contributed to the productivity slowdown. Australia tends to rank low in the OECD (between 20th and 30th) on global innovation indexes and extremely low in terms of innovation efficiency.[61] SMEs face higher barriers to innovation and accordingly innovate and collaborate a lot less often.[62] This may create a reduced likelihood of productivity growth from SME innovation despite the relatively more significant pay-off from SME innovation (see Chapter 4). Australia's rate of innovation appears to be relatively slow compared to leading OECD countries (see Chapter 4). This is especially stark for large Australian businesses which rank almost last in the OECD on innovation and collaboration despite their larger spend on intangibles such as R&D.

Innovation results from a range of complementary assets that go beyond physical capital accumulation. New methods for measuring this 'intangible capital' are being used around the world to measure investment in innovation-related assets such as skills development, R&D, design, organisational improvements etc (Chart 1.3).[63] Intangible capital has been described as the 'glue' that creates value from labour and physical

57 D'Arcy P & Gustafsson L (2012) Australia's productivity performance and real incomes, *Reserve Bank of Australia Bulletin, June quarter*.

58 OECD (2010) *Measuring Innovation: A New Perspective*, OECD, Paris, p.23.

59 DIISR (2011) *Australian Innovation System Report – 2011*, Department of Industry, Innovation, Science, Research and Tertiary Education, Canberra, Chart 3.9, p.60.

60 The 2010-11 data is incomplete; further applications for the 2010-11 income year will continue to be received up to 31 October 2012 from companies with non-standard income period balance dates.

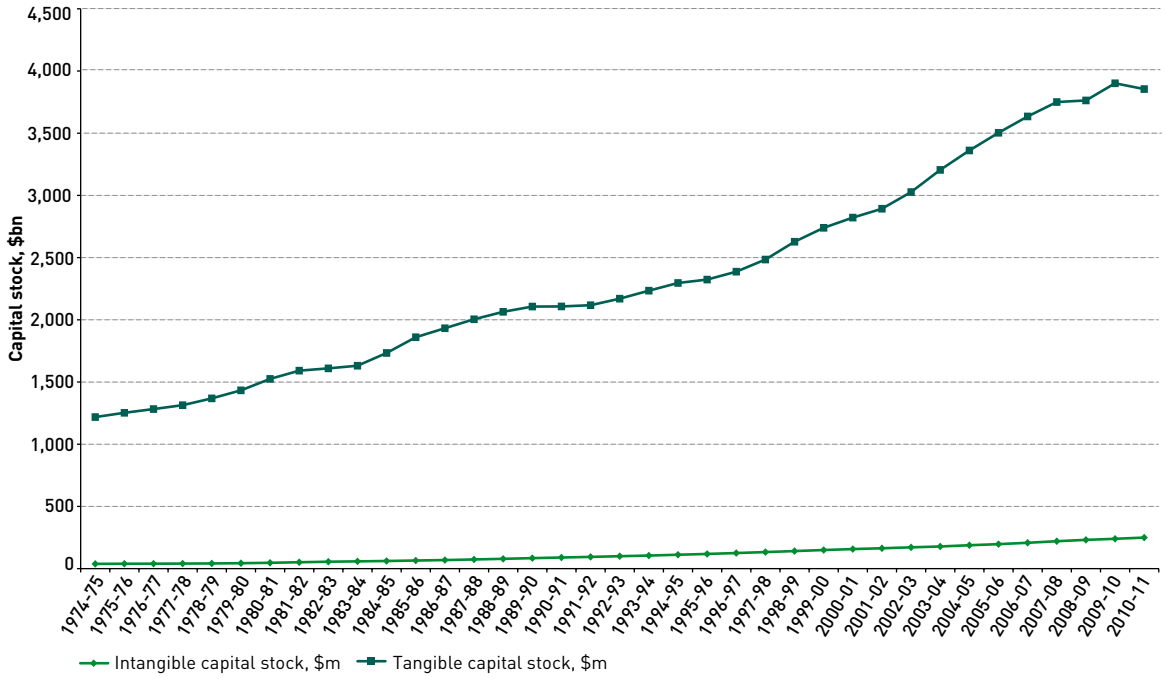
61 See World Economic Forum (2012) Global *Competitiveness Index 2012-13* http://reports.weforum.org/global-competitiveness-report-2012-2013/#=, and INSEAD and the World Intellectual Property Organisation (2012) The *global innovation index 2012*; http://www.globalinnovationindex.org/gii/index.html, [Accessed 19 September 2012].

62 See Chapters 4 and 5 for a more detailed discussion of firm size and innovation.

63 Corrado C, Hulten C & Sichel D (2006) Intangible Capital and Economic Growth, NBER Working Paper no. 11948, National Bureau of Economic Research, Cambridge, Massachusetts.

capital.[64] Chart 1.4 uses this method and shows that intangible capital investment has continued to grow at a compound annual growth rate of 5.3% since 1974-75 and the total stock was estimated to be around $250 billion in 2010-11. The intangible stock has generally grown faster than the stock of physical capital for knowledge economies around the world, and Australia is no exception.[65] However, it is important to note that the more innovative countries have a greater investment in intangibles than physical capital as a share of GDP, at least in later years (Chart 1.5). If this investment behaviour represents a positive shift towards a more innovation-oriented economy a considerable gap remains between Australia and other advanced OECD countries.

Chart 1.4: Market sector intangible and tangible capital stocks, 1974-75 to 2010-11



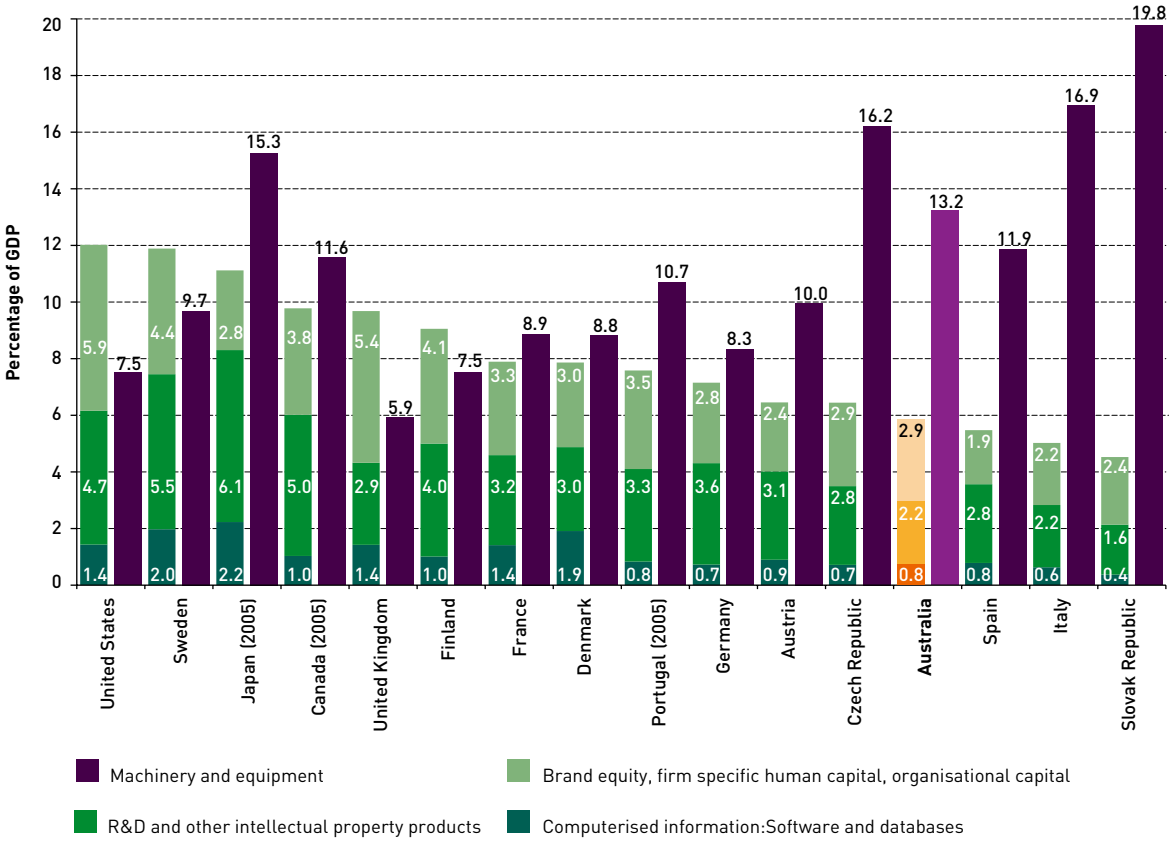
Source: ABS (2012) *Australian System of National Accounts*, cat. no. 5204.0; Melbourne Institute of Applied Economic and Social Research (2012) Figures commissioned by the DIISRTE. Note that intangible capital investment includes R&D, Design, Market research & Branding, Organisational improvement, Business-specific training and skills development, Software development, Mineral exploration and Artistic originals.

The growth in investment in intangibles is a positive trend. However, the scale of investment may not be matching the investment in machinery and equipment sufficient to lift productivity. Chart 1.3 shows that growth in physical capital has outstripped complementary intangible capital investments (the ratio changed from 1:3 to above 1:4), and may suggest an unhealthy investment situation for productivity in the short term. With the incentive to make large capital investments (high demand, high Australian dollar and low interest rates), we are not yet getting an efficiency gain from the management of more balanced physical/intangible investments similar to that which occurred during the late 1990s. In the long term, however, as lag effects and intangible investments catch up, Australia may return to a more productive use of its asset base.

64 Cummins J (2005) A new approach to the valuation of intangible capital, in Corrado C, Haltiwanger J and Sichel D (eds), *Measuring Capital in the New Economy: Studies in Income and Wealth*, vol. 65, National Bureau of Economic Research, Chicago, pp. 47–72.

65 Barnes P & McClure A (2009) *Investments in Intangible Assets and Australia's Productivity Growth,* Productivity Commission, Staff Working Paper.

Chart 1.5: Investment in physical capital and intangibles as a proportion of gross domestic product, 2006



Source: OECD (2010) *Measuring Innovation: A New Perspective*, OECD, Paris.
The 16 OECD countries are ranked by total expenditure in intangibles assets as a percentage of GDP. Investment in intangible assets is provided in the three categories: computerised information, innovative property and economic competencies. Investment in fixed assets (machinery and equipment) is shown in purple as a contrast with intangibles for each country. This is only one component of physical capital.

A possible explanation of this 'imbalance' in physical to intangible capital investment is that the majority of Australian businesses are currently adopters and modifiers of others' innovations (for instance, playing catch up through technology adoption) rather than delivering world-first innovations (pushing the frontier).[66] Australia has extremely low proportions of 'new to the market international innovators' (1.5%) compared to other OECD countries (between 10% and 40%) which have a different, perhaps more balanced investment pattern. So businesses, particularly trade-exposed businesses, may be innovating to achieve other goals rather than necessarily climb up the global value chain. Expenditure on innovation by Australian businesses was estimated to be between $23 billion and $29 billion in 2010-11.[67] The investments most likely to be made by these businesses were in acquisition of machinery, equipment or technology (36%); training specific to innovation (27%) and marketing activities undertaken to introduce innovation (26%).[68] These data suggest an innovation system that is geared towards an effective strategy of *fast followers*: early adopters of new ideas, rather than inventors.[69]

The high Australian dollar and other factors are introducing significant competitive pressures to trade-exposed non-mining industry sectors such as manufacturing, tourism, education and parts of the agricultural sector. These pressures may improve management capability and drive investment in organisational and managerial innovation leading to significant productivity improvements as non-innovative businesses are displaced by innovative ones better adapted to a new competitive environment.[70]

66 See DIISR (2011) *Australian Innovation System Report – 2011*, Department of Industry, Innovation, Science, Research and Tertiary Education, Canberra, p.23, but also Technology Balance of Payments data in Table 5.2 of this report.

67 ABS (2012) *Innovation in Australian Business, 2010-11*, cat. no. 8158.0, Appendix 2.

68 ABS (2012) *Innovation in Australian Business, 2010-11*, cat. no. 8158.0.

69 Arundel A (2011) *Skills for an Innovative Australia to 2025*, paper for Skills Australia scenario development forum, Sydney, February.

70 Lowe P (2012) The changing structure of the Australian economy and monetary policy, *Reserve Bank of Australia Bulletin*, March; Bloom N, Dorgan S, Dowdy J & van Reenen J (2007) *Management Practice and Productivity: Why They Matter*, Centre for Economic Performance and McKinsey & Company, July.

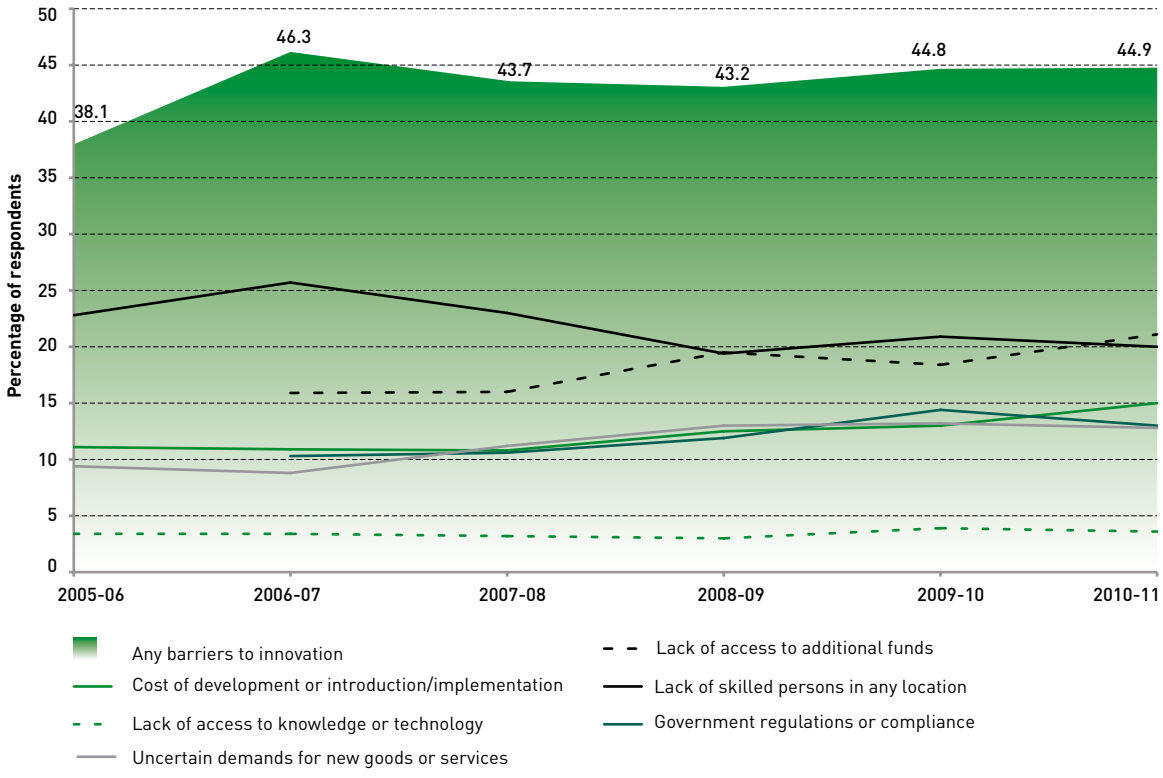
Barriers to investment in innovation

Investment in more novel forms of innovation is lagging behind technology adoption and we have a low to moderate proportion of innovators compared with other OECD countries. What is preventing Australian businesses from investing in innovation that could bring about a reorganisation of production sufficient to significantly increase productivity?

Chart 1.6 shows key barriers to innovation perceived by businesses across Australia. The data suggests a small increase in 'any reported barrier' to innovation to around 45% of all businesses in 2010-11. This chart also shows that limited access to either skilled people (further explored in Chapter 3) or additional funds (further explored in Chapter 4) remain the two most common perceived barriers to innovation. However, lack of access to skilled people either within the business or the labour market has eased in recent years, compared to all other barriers which have increased to varying degrees. Generally small businesses, with fewer resources, are more likely to experience barriers to innovation than large businesses in Australia (data not shown) and the result is less innovation (see Chapter 4). Interestingly, lack of access to knowledge and technology is the lowest reported barrier to innovation suggesting that there is no system-wide shortage of new technology. A lack of skilled people is a relatively high barrier, implying that accessing embodied or tacit knowledge in other organisations is still an issue.

These reported barriers look generally at so-called *framework conditions,*[71] in other words, how the external environment influences business decisions to innovate. These themes are further explored in later chapters. However, this data does not attempt to describe how the internal environment, such as business management competency and innovation culture, affect business decisions to innovate.

Chart 1.6: Barriers to innovation for all Australian businesses, by type, 2005-06 to 2010-11



Source: ABS (various) *Selected Characteristics of Australian Business and Innovation in Australian Business*, 2005-06 to 2010-11, cat. no. 8167.0 and 8158.0.

71 *Framework conditions* are a set of established practices, rules or laws that regulate the interactions between people. See DIISR (2011) *Australian Innovation System Report – 2011*, Department of Industry, Innovation, Science, Research and Tertiary Education, Canberra, p.13

It is increasingly recognised that management capability in businesses is critical for innovation and to creating long-term economic growth.[72] Although many innovating Australian organisations use ideas and technologies developed elsewhere, innovation occurs because managers of organisations (CEOs, directors, operations managers, owner/operators etc.) make internal strategic decisions to mobilise resources, capabilities and creativity to make it happen.[73] Not surprisingly then, innovative, productive, networked businesses tend to be characterised by higher quality, more educated management.[74] Innovative Australian businesses were more than twice as likely to use business and project management and marketing skills than non-innovators, and also three to five times more likely to report skill shortages in these areas (see Chapter 3).

A number of analysts have argued that since the 1990s Australia's prosperity has weakened incentives for the economy to introduce significant productivity enhancing innovations.[75] Organisational innovation, with or without technological innovation, is a driver of MFP improvements[76], and management capability and organisational or business model innovation can explain large differences in productivity between businesses and countries.[77] To achieve maximum productivity and profitability it is therefore important that a business's innovation strategy, business model and culture are aligned.[78] The transition to *e*commerce and *m*commerce[79] is a good example of the power of business model innovation. Innovative businesses are now around twice as likely to engage in the new business models of *e*commerce as non-innovators. Total internet income for innovation active businesses was $144 billion in 2010-11 compared to $44 billion for non innovation-active businesses.[80]

Underpinning business model innovation is high quality business management and leadership. Evidence suggests that Australian business management capability is lagging behind other advanced OECD countries and therefore a factor in the current productivity slowdown (see further discussion in Chapter 4). It has been further argued that improvements to business management of intangible assets and the quality of leadership, culture and management practices would significantly enhance multifactor productivity through the innovative reorganisation of inputs (e.g. business model innovation; see Chapter 4).[81]

In early 2012 it was observed that management education needed to be conducted at all levels instead of focusing on top levels, and that small and medium enterprises are being overlooked though they too would benefit from management education.[82] Chapter 4 shows that innovation appears to deliver a relatively greater pay-off, in terms of productivity, for small businesses compared with large businesses. These businesses are most likely to benefit, but least likely to undertake management training. A recent survey found that Australian managers assess themselves as least capable in the areas of organisation capability and innovation.[83] Taken with the relatively poor innovation culture of Australian businesses described in this report (see Chapter 4), creating a culture of innovation in the management of Australian businesses should lift productivity, particularly through better education of SME managers.[84] This issue has been recognised by the Australian Government which recently announced $12 million over four years for the establishment of a new Centre for Workplace Leadership to improve the leadership capability in workplaces of all sizes.[85]

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79 *m*commerce is commercial activity such as banking and retailing taking place using smartphone technology.

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Features

The following features expand on, and offer interesting counterpoints to, the discussion of productivity and innovation.

FEATURE: PRODUCTIVITY MATTERS

John Quiggin

Professor and Australian Research Council Federation Fellow at the School of Economics, University of Queensland

Productivity matters. Australia's Gross Domestic Product today, produced by 22 million people, is greater than that of 100 million Americans in 1930. 200 000 Australian farmers produce about as much wheat (25 million tonnes a year) as did 30 million American farmers in 1900, and the same is true for many other commodities.

This striking achievement was not the result of hard work. Americans in the early 20th Century worked harder and longer than do Australians today. Standard working hours were 10 hours a day, six days a week, there was no old age pension or annual leave, and even public holidays were few and far between.

Nor was it the result of market-oriented reform. The US government in 1900 was far smaller, in both absolute and relative terms, than is Australia's today. There was little if any regulation of working conditions, product safety or environmental impact. By the standard criteria used in discussions of market reform, the US at the turn of the 20th century was among the most fully liberalised economies the world has ever seen. Yet its productivity was far below that of contemporary economies, including Australia's.

Rather, the central driver of productivity is innovation. Australians today have access to a vast array of technologies undreamed of a century ago, in agriculture, manufacturing, communications, transport, and most striking of all, information technology. We enjoy both new goods and services and radically more efficient methods of production. In the steel industry, already mature in the 19th Century, labour input requirements fell by a factor of 1000 between 1920 and 2000. More recently, the retail sector has been revolutionized by online shopping. Some of these innovations were developed by Australians, but the vast majority were, from our point of view, a free gift from the world as a whole.

And of course, there is nothing exceptional about Australia (or rather, to adapt President Obama's observation, every country is exceptional in its own way). The providential path to higher living standards through the diffusion of innovations is not unique to Australia's history: any developed country will yield much the same story. New Zealand, among the weaker performers in the OECD over recent decades, has higher GDP per person than did the US in 1980. (Ironically, as recently as the mid-1990s, New Zealand was being hailed as a 'miracle economy' on the basis of policies very similar to some of those being proposed as answers to Australia's perceived productivity problems today (Rankin 1995)).

Technology alone is not enough, however. Modern technology is available, and used to some extent, in African countries that are still far poorer than the US of 100 years ago. Tecvwhnology is only valuable for a country whose people have the education and skills needed to use it.

Over periods of decades or longer, productivity is almost entirely driven by innovation and the ability to take advantage of technological progress. Australia can't do much to affect the global rate of technological progress, but we can adopt policies that allow us to enhance the benefits of innovation. These include:

- Promoting R&D and other innovation activities where issues specific to Australia arise, for example in agriculture, mining and ecologically-based tourism and recreation;
- Encouraging the adaptation of innovations developed overseas to Australian conditions (the *Australian Innovation System Report – 2011* notes that this is the most common mode of innovation by Australian businesses);
- Participating in the global knowledge economy by maintaining and developing our own capacity for R&D, design, engineering and other innovation activities. An appropriate mix of pure and applied research is important here.

At least as important is the need to ensure that Australians have the education and skills required to take advantage of innovation and thereby improve productivity. This is a moving target. As recently as the 1970s, there were a great many jobs, even in an advanced economy like Australia's that required little more than a Year 10 education and some on-the-job experience. Today, such jobs have largely disappeared, and those that remain are commonly filled by teenaged part-timers.

This process is continuing. In 1996, professional and managerial occupations accounted for about 30% of total employment, white-collar and skilled blue-collar occupations for about 40%, and low-skilled occupations (labourers, sales workers and machinery operators) for the remaining 30%. By 2012, the share of professional and managerial occupations had risen to 35%, while that of low-skilled occupations had fallen to 25% (ABS 2012).

The majority of jobs being created in the modern economy require not only high-school completion, but some post-secondary education, whether at university, in the vocational education and training sector, or through apprenticeships and traineeships. Australia has made good progress in increasing school completion rates and participation in post-secondary education and training. Nevertheless, substantial challenges remain and a number of recent developments raise serious concerns about our future capacity for successful innovation. These include:

- Slow progress towards the goal of universal high school completion. At 74%, Australia's secondary school completion rate is among the lowest in the OECD (Australian Government 2010);
- The reliance of the higher education system on income from overseas students who may go elsewhere (17.5% of total income, compared to 11.7% from HECS-HELP (DIISRTE 2012).
- Funding cuts in the TAFE system at the state level, which threaten the most vulnerable students (The Courier 2012);
- Chronic difficulties in the apprenticeship and trainee system, reflected in low completion rates and highly variable outcomes (Apprenticeships for the 21st Century Expert Panel 2011).

Measures to address these problems have been put forward, but many of them have been deferred as a result of the budgetary problems that have followed the global financial crisis. It is important that short-term concerns of this kind should not be allowed to damage our long-run prospects as an innovative, productive economy. Australia's strong budgetary position means that we are well placed to make productive investments in education and innovation at a time when governments in many developed countries are facing severe constraints

While many of the points raised above may seem like common sense, they bear little relation to the issues being debated with reference to 'productivity' in Australia today. This discussion is focused almost entirely on short-term variations about the long-run trend in productivity growth, variations that reflect a combination of macroeconomic factors, the balance of power in labour markets and the difficulty of measuring productivity exactly.

The most common narrative here (for example, Eslake 2011) is that Australia experienced a 'surge' of productivity growth in the 1990s followed by a slowdown in the decade after 2000 (Quiggin 2006 discusses some other 'stories about productivity'). The suggested responses focus almost entirely on workplace changes that may be summed up as 'working harder and working smarter' (Banks 2011).

It is widely recognised that the apparent productivity slowdown evident in the data for the period since 2000 is due, at least in part, to measurement error. The mining boom has attracted huge amounts of capital, and substantial amounts of labour to projects that would not have been economic at the prices prevailing in the past. Although these investments are economically sensible, they show up as a slowdown in productivity (Parham 2012).

It is less widely recognised that the surge of the 1990s was also largely illusory (Quiggin 2001). Measured productivity fluctuates in line with the economic cycle. In the early years of a recession, productivity typically declines as businesses reduce the utilisation of both physical capital and labour. Businesses are mostly unwilling to dismiss workers in the early stages of a slowdown, since they will need to rehire them in the event of a recovery. So, they remain on the job even though there is not much work for them to do. However, in a long and deep recession, this reluctance eventually disappears.

In the early stages of a recovery, such as that of Australia in the 1990s, businesses are slow to rehire workers, producing the well-known problem of a 'jobless recovery'. The safe response, made easy by the fear of unemployment, is to drive the existing workforce harder.

Work intensification shows up as an improvement in productivity, but it is not necessarily beneficial. In economic terms, productivity improvements gained this way are only beneficial if the extra output produced by workers is of more value to them than the extra time and effort put into producing it.

When the labour market returns to more normal conditions, as happened at the end of the 1990s, the increased bargaining power of workers is reflected in the return of a more sustainable work-life balance, with less unpaid overtime and a less punishing pace of work. This is economically both inevitable and desirable, but it shows up as a slowdown in measured productivity growth. In reality, productivity has continued to improve, but more of the benefits are being allocated to improvements in leisure and work-life balance (Quiggin 2012).

Improvements in leisure benefit workers, but discussion of the issue is dominated by employers and managers who benefit from having their workers work harder. In most cases, their own jobs are enjoyable and rewarding so managers are willing to accept long hours and periods of intense effort. So, it is unsurprising that most discussion of the need to improve productivity focus on policies that would make Australians work harder and longer.

Such discussions divert attention from the main game in productivity growth. In the long run, productivity growth comes from innovation and education. If we focus on ensuring that Australians can develop innovations relevant to our needs as a nation, and that we have the skills and capacity to adopt and adapt innovations developed overseas, we can ensure a continuation of the long run growth trend in productivity and living standards. This is the primary issue in economic policy.

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FEATURE: THE ROLE OF INNOVATION AND PRODUCTIVITY IN THE MACROECONOMIC CHALLENGE

Professor the Hon Stephen Martin

Chief Executive
CEDA – the Committee for Economic Development of Australia

Australia's current economic prosperity owes much to the sweeping economic reforms of the 1980s and 1990s, the minerals boom and associated investments and fiscal and monetary policy working in tandem to secure Australia's continued resilience in the face of global uncertainty.

However, a lack of global competition and a relatively stable economy over the last decade has created a complacent society and has provided limited incentive for business to innovate. In part this has probably contributed to our productivity slowdown and must be addressed as a matter of urgency.

While some would ask why this is an area of such concern, with recent statistics for GDP growth and employment painting a picture of an economy on steroids, we need to take a long-term view.

Economists and policy-makers generally assume that the current elevated terms of trade will return to more normal conditions while business investment will continue for several years to support GDP. However many of these assumptions are based on Australia's continuing trade relationships with our Asian neighbours, specifically in commodities, and the view that these will continue at current levels. A key factor to consider is the sustainability of China's growth and whether a rapid decline in demand for Australia's resources may occur if there is a drop in China's economic activity. It is critical to note in this respect that the actions of other resource-rich nations, particularly in Africa are also relevant. While Australia has a 'first mover' advantage in exploiting resources, in the medium term the exploration and investment underway elsewhere will have a major influence on the terms of trade and the willingness of business to continue high-level investment in Australia.

New global competitors and the predicted eventual slowdown in mining-related activity is why areas of potential jobs growth in the future must be our focus now if we are to capitalise on any emerging opportunities.

Australia's current economic prosperity has been supported by past policies that have focused the nation on its international competitive advantage, including innovation and educational up-skilling, and that focus needs to be reinvigorated. But it must be targeted.

Continued technological advances, particularly ICT-related technology, are making goods and services increasingly tradeable on global markets. While this represents a potential opportunity for a highly educated nation such as Australia, it also represents a potential challenge to sectors of the economy that have not been globally integrated or exposed to international competitive pressures in the past. These include significant parts of the services sector such as health and education.

With the mining boom taking the spotlight in recent years, it is easy to forget that the services sector provides 80% of Australia's employment and when the resource-related investment diminishes, as is likely at some stage, future employment opportunities will most likely continue to predominantly be in the services sector.

Some of these sectors are not as productive, at least not as measured by official statistics, as other areas of the economy and the ability of them to therefore lift productivity – of which their ability to innovate will be a key factor – is vital.

If this is not addressed now, Australia's future potential for productivity growth may be at risk, and this may have consequences for continued economic prosperity. With the right reform agenda in place for key sectors such as services we can ensure future economic growth. We would only need to improve Australia's productivity growth to around 1.5% per annum, although still low by historical norms, to potentially underpin robust economic growth for the next decade.

With an ageing Australian population and improving prosperity in Asian nations, it is more important than ever that these sectors are exposed to meaningful reform to enhance their effectiveness and capacity for innovation. Export opportunities are expected to be robust, but only if their potential is realised through an appropriate policy mix. Improving productivity in the services sector, such as education and health, must be a priority if Australia is to maintain its strong economic growth into the future. This will require all participants, be they government, businesses or unions to work cooperatively to deliver the key outcomes Australians expect in a developed economy.

Increased investment in skills, in particular science, research and technical skills, is a vital component, and would allow us to be a leader in high value, high-tech products and knowledge.

Investment in skills has a two-fold benefit - ensuring innovation in the mining and resources sector allows us to continue to compete as other countries emerge as competitors and also ensures we have the right skills available for the likely growth in the services sector. We need reforms in these sectors that focus on building competitive capability to ensure they are better equipped to adjust – and innovate – as future competitive pressures evolve. However it cannot simply fall to government to determine and implement the necessary changes.

The private sector needs to step up as well and invest far more in innovation, R&D, improving productive capacity through new business systems and cooperative working relations and not simply put their collective hands out for government subsidies.

Recognition of the need for vital economic change helped drive the public acceptance of the sweeping reforms of the 1980s and 1990s. These have been key factors in protecting Australia from the international economic turmoil of recent years. The current economic climate provides a real opportunity to again drive a reform agenda with a long-term vision, but it must be driven in unison by both government and business.

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www.ceda.com.au

CHAPTER 2

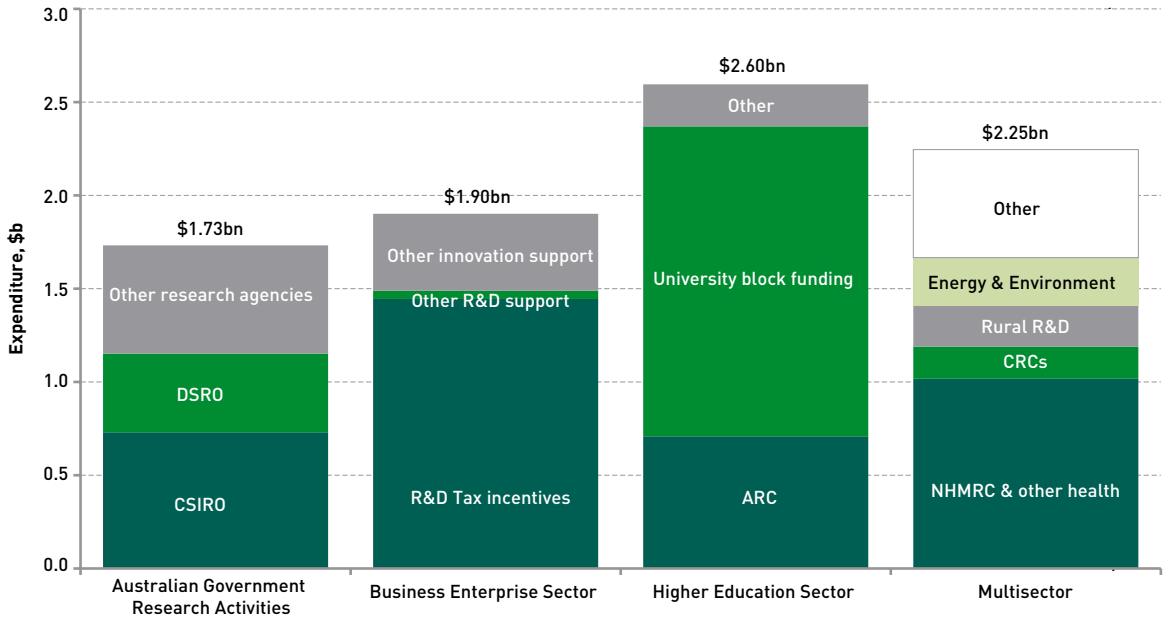
Public research capacity and innovation

The importance of research to innovation and productivity

The research sector has a fundamental role in lifting innovation and hence productivity by generating new knowledge and absorbing existing knowledge from around the world.[86] Evidence of the impact of R&D on productivity comes from many studies.[87] Moreover, a 1% increase in public R&D would result in a 0.28 percentage point increase in the long run rate of productivity growth.[88] By way of example, the Cooperative Research Centres (CRC) have produced technologies, products and processes making an annual contribution of $278 million to the economy, or around 0.03 percentage points to GDP growth per annum.[89]

This chapter discusses trends in Australia's research performance and its orientation towards industry and includes a number of case studies and a feature on the health of Australian science. There are a significant number of government research support programs across Australia. New policy developments in this area can be found in the compendium of program updates accompanying this report at www.innovation.gov.au/AISreport2012/program_compendium. More detail on the compendium can be found in Appendix 1.

Chart 2.1: Australian Government expenditure on science, research and innovation, by category, 2010-11



Source: DIISRTE (2012) *2012-13 Science, Research and Innovation Budget Tables*, www.innovation.gov.au

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Government investment in R&D

The Australian Government's total investment in science, research and innovation was $8.47 billion in 2010-11 (Chart 2.1). This estimate is based on the internationally recognised definition of R&D.[90] Breaking down this total expenditure on science, research and innovation shows that the public research sector receives the majority of investment. It is important to note that this data does not include the government's significantly larger investments in business advisory services, skills, infrastructure and the regulatory environment that underpin innovation.

Research performance

As mentioned in Chapter 1, access to knowledge or technology is a relatively low barrier to business innovation in Australia. Table 2.1 describes Australia's recent research investment and performance and also compares Australia to other OECD countries. Measures of R&D as a proportion of GDP indicate the intensity with which resources are devoted to the research effort relative to a country's overall economic capacity. Australia's investment in research capacity relative to the other 34 OECD countries is mid-range both in OECD ranking and our distance from the higher spending countries (Table 2.1).

Table 2.1: Australia's investment and performance in research against other OECD countries

Indicators	2006	2007	2008	2009	2010	2011	OECD average (latest year)	OECD top five average (latest year)	Gap from the top 5 OECD performers (latest year)	Ranking against OECD countries (latest year)	Change from baseline year to latest year (Baseline in bold)
GERD as a % of GDP[1][r][nd]	**1.99**	-	2.24	-	-	-	2.35	3.80	41%	12th	12%
GERD per capita (current PPP$)[1][r][nd]	**740**	-	876	-	-	-	798	1392	37%	14th	18%
Government-financed GERD as a % of GDP[1][r][nd]	**0.75**	-	0.77	-	-	-	0.68	0.91	15%	7th	3.0%
GBAORD as a % of GDP[1][r]	0.51	0.46	0.46	**0.52**	0.53	0.51	0.75	1.01	49%	18th	-0.5%
HERD as a % of GDP[1][r][nd]	**0.50**	-	0.54	-	-	-	0.40	0.73	26%	11th	7.5%
GOVERD as a % of GDP[1][r][nd]	**0.28**	-	0.27	-	-	-	0.26	0.39	30%	10th	-3.9%
Share of world publications[2][r]	3.02	3.04	**3.19**	3.24	3.35	-	2.85	11.12	70%	10th	5.1%
Share of world's top 1% highly cited publications, natural sciences and engineering[3][y]	3.75	**3.92**	4.37	4.74	4.99	5.28	4.20	17.47	70%	8th	35%
Share of world's top 1% highly cited publications, social science and humanities[3][y]	2.78	**3.18**	3.41	4.10	4.56	4.63	3.20	15.91	No Gap	5th	45%
Citations per publication[2][r] [y]	4.80	5.01	**5.25**	5.50	5.71	-	5.44	7.58	25%	18th	8.8%
Relative impact of publications[2] [r] [y]	1.09	1.11	**1.13**	1.15	1.19	-	1.14	1.58	25%	18th	5.1%
Number of fields with higher than world average citation rate by field*[2][r]	17	17	**19**	19	19	-	n/a	n/a	n/a	n/a	No change

Sources:
1 OECD Main Science and Technology Indicators database, 2012/1.
2 InCites™, Thomson Reuters (2011).
3 InCites™, Thomson Reuters (2011), special request.

Notes: Indicators with * and in the highlighted rows of the table are the primary indicators applied to measure and monitor progress against the Australian Government's innovation targets. (a) OECD rankings are performed on those OECD countries for which data is available. Individual data availability may vary between indicators. Rankings from previous reports have been revised and may vary as a result. [r] The data may have been revised according to the latest available data. [nd] No new data. [n/a] not available. [-] not applicable. [y] Years span four year ranges i.e. 2006=2002-2006.

90 OECD (2002) *Frascati Manual 2002: Proposed Standard Practice for Surveys on Research and Experimental Development*, 6th Edition, OECD, Paris.

In 2008, Australia's gross expenditure on R&D (GERD) was 2.24% of GDP, slightly below the OECD average of 2.35% of GDP. Australia ranked 12th out of 31 OECD countries on this measure, above the UK, Canada and France but some distance behind leading countries Israel, Finland, Sweden, Japan and Korea, which devoted an average 3.80% to R&D. More recent estimates for Australia's GERD shows that in 2010-11 GERD for Australia was $30.8 billion, an increase of $2.5 billion (or 9%) over 2008–09. GERD as a proportion of GDP fell slightly to 2.22% in 2010–11.[91] OECD country comparisons are not yet available for 2010-11.

Research and experimental development is performed and funded by the business, government, higher education, private-non-profit sectors. The distribution of research across these sectors in Australia has changed considerably over the past 15 years[92] with government maintaining a strong role in the funding, if not the performance, of R&D. The proportion of Australia's GERD financed by government was 0.77% of GDP, the seventh highest such contribution in the OECD. Government expenditure on R&D (GOVERD) and higher education expenditure on R&D (HERD) were each slightly above the OECD average (Table 2.1).

Australia's share of the world's publications has grown incrementally over the past five years to 3.4% in 2010 (Table 2.1). This ranked Australia 10th in the OECD, although the distribution of the world's publications is highly skewed, with the top five countries producing 56% of the world's total and the USA alone, 28.7%. At 402 publications per thousand researchers, the productivity of Australian researchers is 7th highest in the OECD.[93]

Table 2.1 shows that our levels of investment in R&D are increasingly generating high quality research output. A commonly used indicator of the quality of a country's research is the citation rate of its publications. Australia's 5.7 citations per publication in the period 2006-10 was 19% higher than in the period 2002-06 but ranks 18th among the 34 OECD countries (Table 2.1). In 19 of 22 research fields, the citation rate of Australia's research publications was above the world average. Between 1996-2000 and 2006-2010, Australian research publications recorded significant increases in relative impacts in 18 of the 22 research fields (data not shown), the largest increase occurring in multi-disciplinary research.[94] The relative impact of research fell, however, in Space Science, Agricultural Sciences, Engineering and Mathematics. [95]

The quality of Australian research output is also evidenced by Australia's share of the world's top 1% of highly cited publications. This figure was around 6% between 2009-11 putting Australia in the top ten countries for research quality (Chart 2.2). The last six years has shown high growth rates in these indicators driven by growth in natural sciences and engineering as well as social sciences and humanities research (Chart 2.2). Interestingly, high quality Australian research has grown faster in the humanities and social science disciplines than it has in natural sciences and engineering over the last six years, albeit from a lower base. Unlike natural sciences and engineering, high quality single author publications are more dominant and also growing in the social sciences and humanities suggesting a general lift in research quality in those disciplines (Chart 2.2).

91 ABS (2012) *Research and Experimental Development, Businesses, Australia, 2010-11,* cat. no. 8104.0.

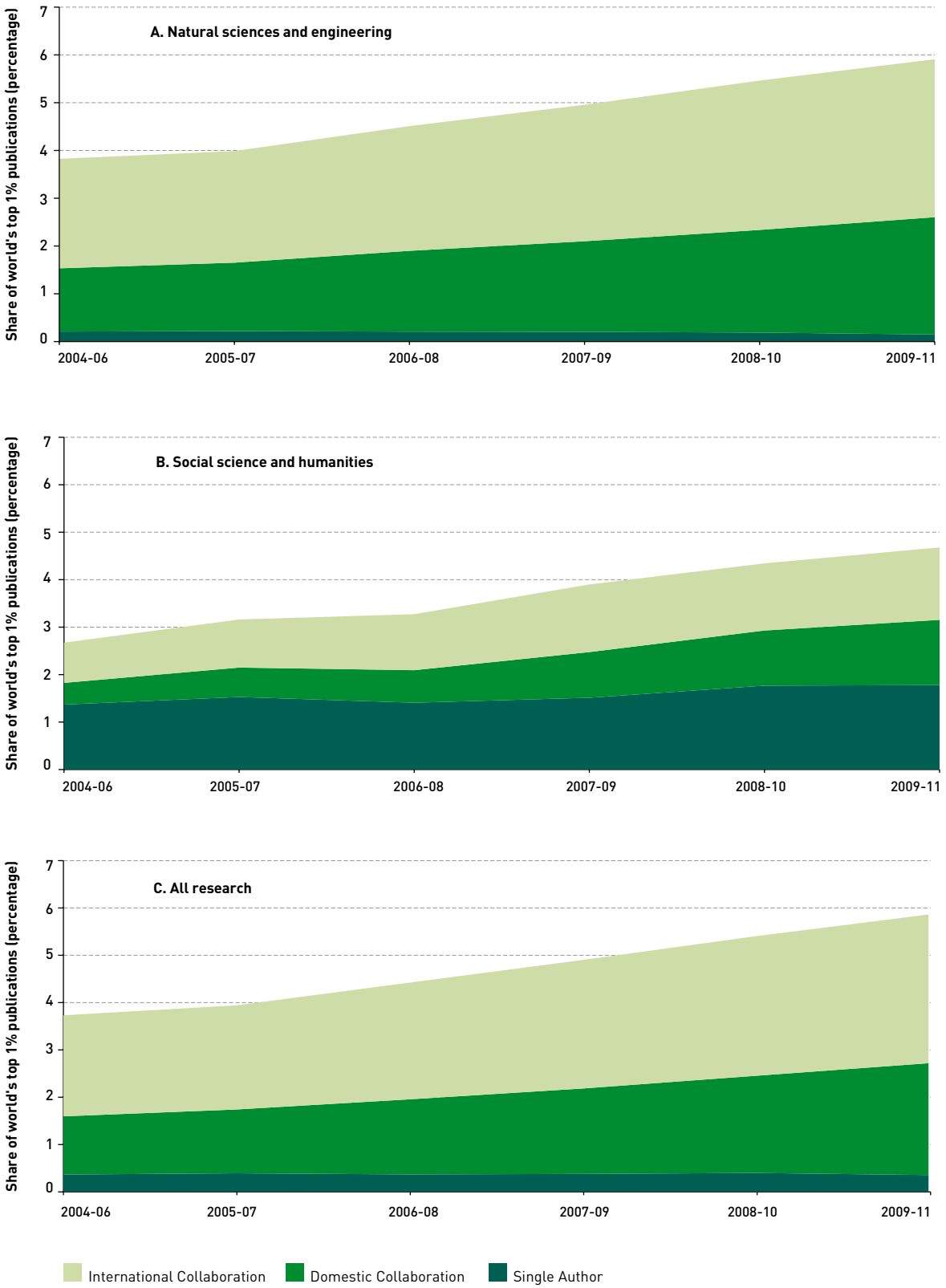
92 See *Australian Innovation System Report – 2011,* pp.19-20.

93 Thomson ISI, *National Science Indicators* database, 2010.

94 Interpretation of this category must be with caution. Multi-disciplinary research refers not only to research that is based on multi-disciplinary teams, but also research which has been published in a non discipline specific publication.

95 *Ibid.*

Chart 2.2: Australia's share of the world's top 1% research publications, by research field, by type of collaboration, 2004-2006 to 2009-2011



Source: DIISRTE special data request from Thomson Reuters (2012).

FEATURE: THE HEALTH OF AUSTRALIAN SCIENCE

Image provided by the Office of the Chief Scientist

Australia's Chief Scientist Professor Ian Chubb AC.

In May 2012 Australia's Chief Scientist, Professor Ian Chubb AC, released the *Health of Australian Science* report. The evidence presented in this report suggests that Australian science is generally in good health. Our school students compare well on the international stage. At present there is growth in science enrolments in universities. Our researchers produce more per capita than researchers in most other nations and have impacts at or above world standard in most discipline areas.

But there are some immediate concerns also, and challenges in the short to medium term. Science participation in the senior years of school has fallen. Although the rate of this decline has slowed, participation rates have not yet stabilised. Compared with other nations, secondary school performance in science literacy is also slipping. Despite a recent increase in science enrolments at university, the trend has been flat for most of the past decade and has not recovered to the levels achieved in the early 1990s.

The research community has enjoyed increased levels of funding in the past decade, but this funding has been under increasing pressure as a result of rising demand by researchers. Australia's output of research publications is high and Australian publications are cited at or above world average rates in most fields of research. In most scientific fields Australian researchers collaborate internationally and contribute well. This is where the strength lies in the current system. The vulnerability lies in the several narrow fields that may fail to maintain capability in the short to medium term if current trends continue.

Despite a robust science system overall, some disciplines that are vital to Australia's future are diminishing to an extent; examples are agriculture, chemistry, mathematics, and physics. Importantly, this includes the so-called enabling sciences (mathematics, physics and chemistry), which form the basis of education and research in all science.

There is arguably a need for a clearer focus on particular areas of education and research if we are to ensure a level of excellence in areas that are crucial to Australia's future and our place in the world. This is not an argument for supporting only those areas: Australia needs a broad base from which to work. We need to be able to anticipate new questions of importance and to use the skills from the broad base to develop our own responses and our contribution to global responses. We need also to fully develop our potential in translational research and innovation.

Website for more information:
www.chiefscientist.gov.au

Research orientation towards industry and innovation

This section deals with the orientation of the research sector (higher education, government and private non-profit institutions) towards applied research and also economic development. Collaboration between the research sector and industry is elaborated on Chapter 5.

Universities and other research institutions are increasingly seen as not only sources of knowledgeable students and exploitable ideas, but also as direct contributors to economic development through the creation of spin-off businesses, the trade of intellectual property and the creation of a significant international education industry. The data in this report describes a situation where industry has a small proportion of new-to-international-market innovations (which requires more research and engineering skills; see Chapter 3 and 4), relatively moderate to low rates of innovation (Chapter 4) and yet a research sector with a strong record in terms of both quantity and quality of output.

There has been ongoing debate in Australia as to the nature and the scale of the interaction between the research and industry sectors and/or the orientation of the research sector towards the practical, problem-solving aspects of economic development. The ability to produce, identify, and exploit knowledge depends on the existing knowledge stock and the absorptive capacity of both businesses and research institutions. The existing knowledge stock might not be commercialised to its full extent. Therefore knowledge flows must occur and transmission channels are needed.[96] The extent to which this should be pursued is debated. The research sector, particularly universities, plays a potentially more important function of educating the future workforce.

Applied research (research undertaken primarily to acquire new knowledge with a specific application in view) is a critical input to the innovation system and is often seen to be more immediately relevant and applicable for end-users, specifically industry, than basic or 'blue sky' research. Typical of most OECD countries, the business sector's expenditure on R&D (about a third of which is from SMEs) is heavily weighted to applied research and experimental development, accounting for 94% of all business expenditure on R&D in 2008-09 (Chart 2.3). The research sector, by contrast, is more balanced: 50-70% of expenditure on research is directed to applied research and experimental development while the rest is directed to pure basic or strategic basic research (Chart 2.3).

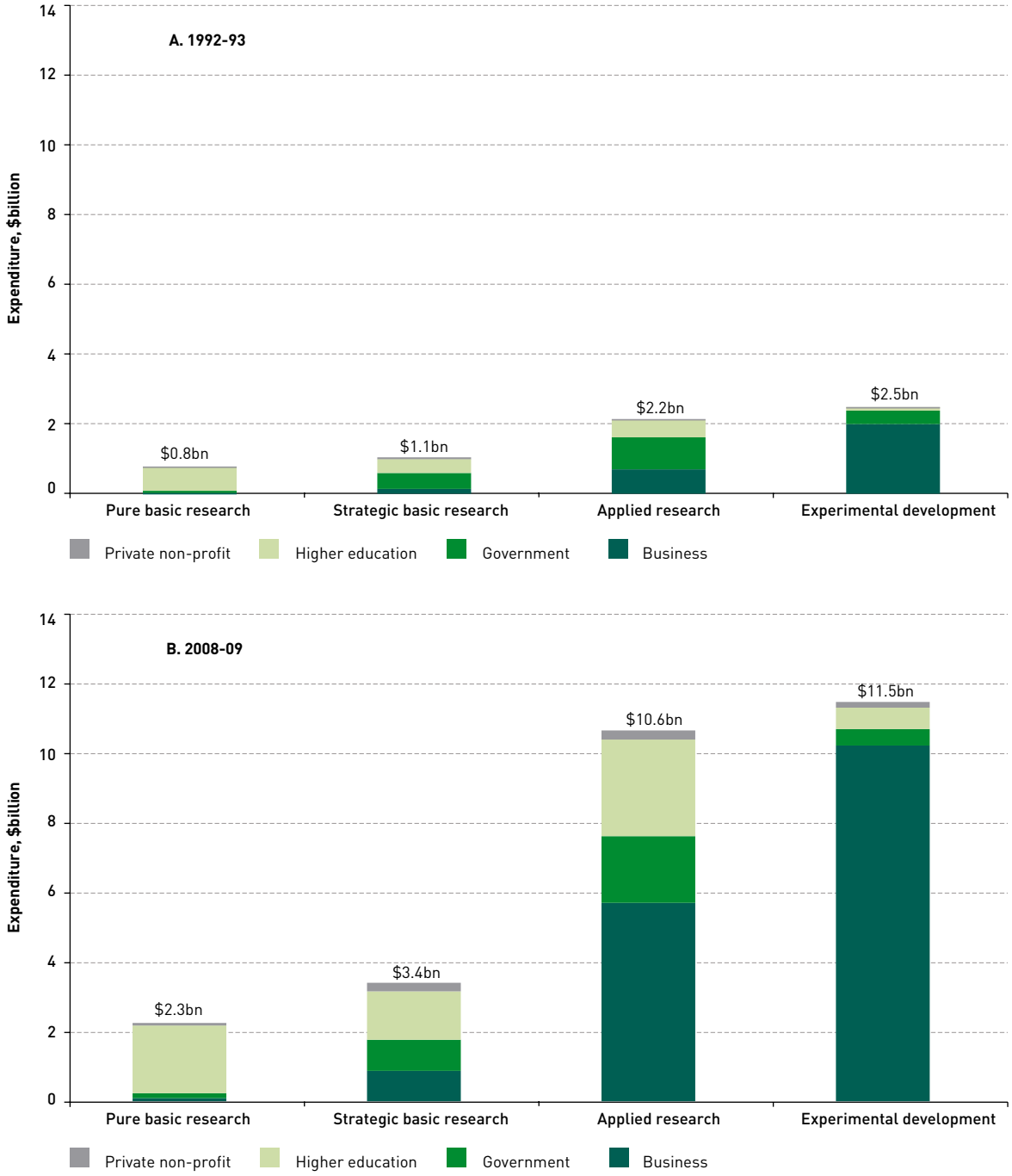
Although the research sector is more focused on basic research than industry, the research sector has been re-orienting itself towards more applied research since the early 1990s. Total research sector expenditure on applied research and experimental development has grown five fold since the early 1990s (Chart 2.3). By contrast total basic research and strategic basic research has grown two and three fold, respectively, in the research sector.

In relative terms the growth rates of business sector applied research and experimental development have been higher than those of the research sector. The result is that the relative proportion of total applied research undertaken in Australia by the research sector has fallen from 67% in 1992-93 to 46% in 2008-09. The decline in the proportion of Australia's experimental development that was undertaken by the research sector is more extreme, declining from 20% to 11% over the same period (Chart 2.3). Applied research is the fastest growing type of R&D in the higher education sector. However, the growth rate of government sector R&D is not keeping pace with the other sectors. The result is that business expenditure is substituting for slow growth in government applied research and experimental development. There may be a direct substitution effect here, especially if the applied research is principally demand-driven.

By breaking down expenditure on R&D by socio-economic objective, the data shows that R&D by the research sector is mostly oriented towards the socio-economic objective of *economic development* (Chart 2.4). If the socio-economic objectives of *defence* and *health* are also included then more than half of higher education and government expenditure on R&D is aimed at the development of major domestic industries (Chart 2.4). The proportion of higher education sector R&D expenditure in these three areas has increased from 43% to 60% between 1992 and 2010. By contrast, the government research sectors' focus on these three areas declined from 76% in 1992-93 to 64% in 2008-09, due to a reduction in expenditure on *economic development*. Again, however a substitution effect may be at work here.

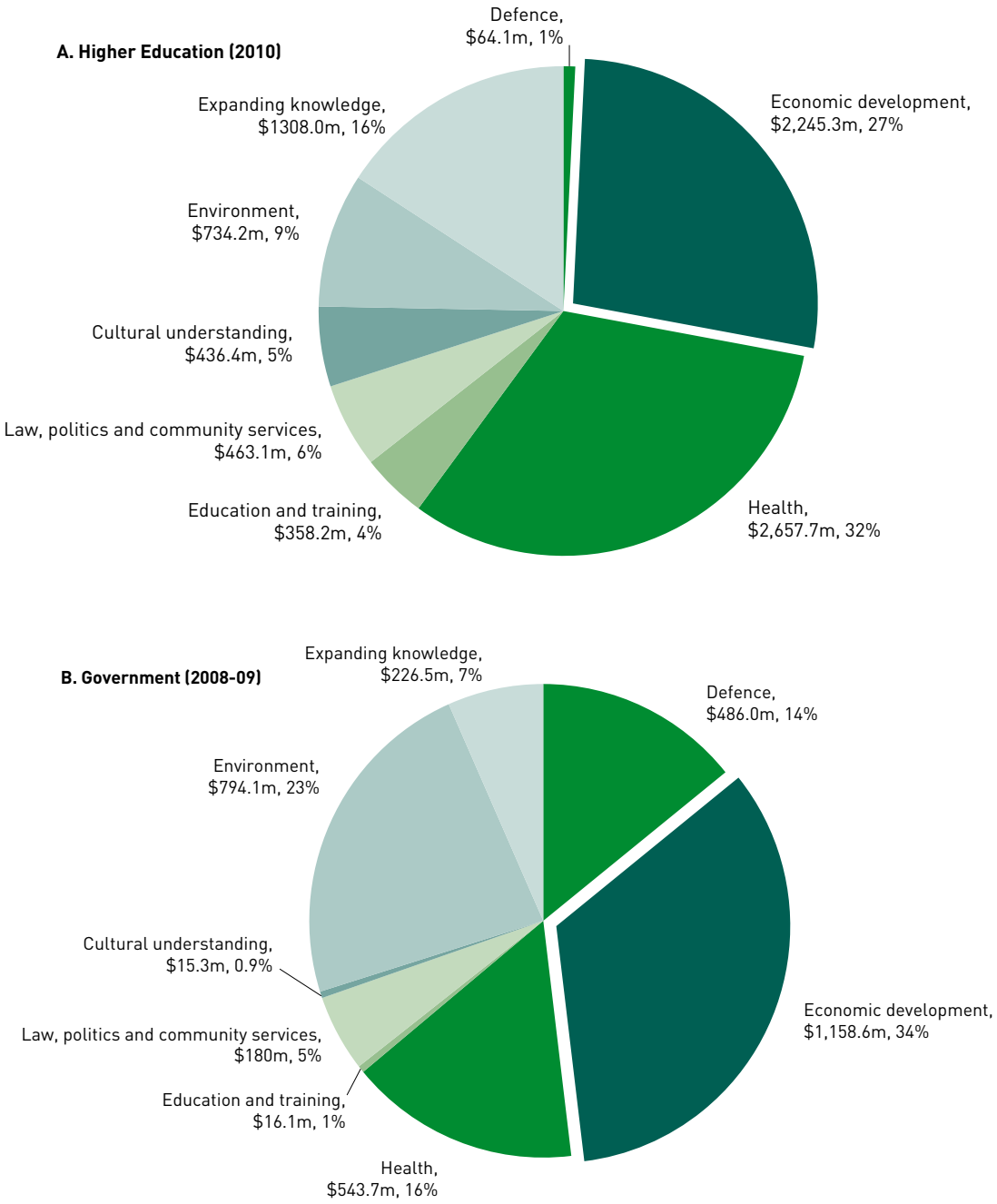
96 Mueller P (2006) Exploring the knowledge filter: How entrepreneurship and university-industry relationships drive economic growth, *Research Policy* 35: 1499-1508.

Chart 2.3: Expenditure on R&D, by sector, by type of activity, 1992-93 (panel A) and 2008-09 (panel B)



Source: ABS (2010) *Research and Experimental Development, All Sector Summary, Australia, 2008-09*, cat. no. 8112.0.

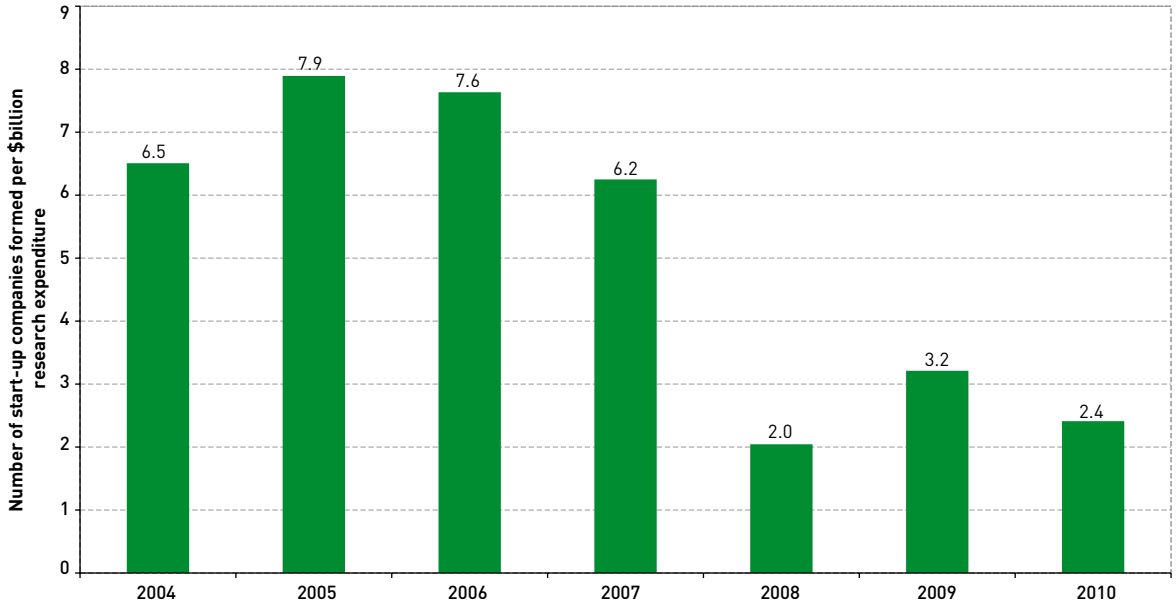
Chart 2.4: Higher education (panel A; 2010) and Government (panel B; 2008-09) expenditure on R&D, by socio-economic objective



Source: ABS (2010) *Research and Experimental Development, Government and Private Non-Profit Organisations, Australia, 2008-09*, cat. no. 8109.0; ABS (2012) *Research and Experimental Development, Higher Education Organisations, Australia, 2010*, cat. no. 8111.0.

Research commercialisation is a process that links research and industry sectors through both the creation of new business ventures and the exchange of knowledge and intellectual property flow from the research sector to industry. Research commercialisation requires significant institutional support and in part represents the orientation of the research sector towards economic development (see also the feature in Chapter 5). Data on research commercialisation is mixed in terms of performance even for the more commercially-oriented universities. In absolute terms many indicators show positive growth. However, R&D activity in this sector is also increasing, in terms of both researchers and expenditures.[97] The number of businesses being launched from the research sector has been declining in absolute and relative terms over the last decade but particularly over the last few measured years (Chart 2.5). It is important to note that these businesses tend to be high-tech ventures relying heavily on venture capital, which has also declined significantly in the last few years (see Table 4.2). The number of invention disclosures per R&D dollar was steady over the 2004-2010 period for Knowledge Commercialisation Australia members. However, the number of patent applications per R&D dollar and the number of licences, options and assignments (LOAs) of intellectual property has declined over the same period. LOA income per R&D dollar appears to be increasing, although this number is erratic over time. Despite growth in the number of research contracts and consultancies per R&D dollar, the value of research contracts and consultancies per R&D dollar has remained steady between 2004 and 2010.[98]

Chart 2.5: Number of start-up companies formed per research dollar, 2004 to 2010



Source: Time series for the 23 Knowledge Commercialisation Australasia (KCA) members that responded to the latest 2010 KCA survey (DIISRTE NSRC database).

97 ABS (2010) *Research and Experimental Development, Government and Private Non-Profit Organisations, Australia, 2008-09,* cat. no. 8109.0; ABS (2012) *Research and Experimental Development, Higher Education Organisations, Australia, 2010,* cat. no. 8111.0.

98 Knowledge Commercialisation Australasia (2012) *Commercialisation Metrics Survey Report 2010*, www.kca.asn.au [Accessed 14 August 2012].

Case studies

Nobel laureate inspires the next generation of world-class astronomers

Professor Schmidt receiving his Nobel Laureate Award for Physics from the king of Sweden

Photo provided by ANU – Professor Schmidt's office

SkyMapper

Photo provided by – ANU produced by Julia Jane Photography

SkyMapper Project Scientist, Nobel Laureate Professor Brian Schmidt and his team will continue their ground-breaking work with the help of a $1 million extension to Professor Schmidt's Australian Laureate Fellowship. The funds will enable the training and mentoring of more students and up-and-coming researchers in a world-class research environment.

SkyMapper is an automated survey telescope, creating an unprecedented, comprehensive digital survey of the southern sky, and providing the survey data to the scientific community and public. SkyMapper is repeatedly imaging the sky and identifying any changes or patterns which will enable astronomers to identify targets for further study using next-generation telescopes such as the Giant Magellan Telescope or the Square Kilometre Array.

"Normally when a telescope looks at the sky, it looks at a narrow patch which is about a hundredth the size of a full moon," Project leader Professor Brian Schmidt explains. "SkyMapper will look at a piece of sky 40 times larger than the full moon. In addition, there will be huge digital cameras behind them that are 100 times more sensitive than normal cameras."

Data will be transmitted at a rate of 100 Megabytes a second to The Australian National University (ANU) supercomputer facility for processing. The telescope will be fully automated, with the astronomers working from the Mount Stromlo Observatory. SkyMapper's main task will be to conduct the first ever systematic survey of the entire southern sky to produce a detailed digital map.

Since SkyMapper will be sensitive enough to pick up some of the most distant and faintest objects, the chart will have a deep time dimension. Because of the time it takes light to reach Earth, the Southern Sky Survey will enable astronomers to look back to the time soon after the Big Bang when the first stars' nuclear fusion reactions set the primeval universe ablaze. This was the time when stars were beginning to manufacture the heavy elements from hydrogen, including iron and carbon, the element that billions of years later would form the basis of life on Earth.

The SkyMapper survey will be used by astronomers across Australia and around the world to undertake a multitude of projects including:

- Uncovering the most distant objects known in the universe – the first quasars that we think formed when the universe was 3% of its current age.
- Discovering large dwarf planets like Pluto in the outer solar system.

- Obtaining a comprehensive map census of the stars in our Galaxy, providing the temperature, composition, and size of more than a billion objects.
- Providing our best map of the invisible material (known as dark matter) which makes up the majority of our galaxy using samples of very rare stars uncovered in the survey.
- Pinpointing the first stars that formed in our galaxy 13 billion years ago by their chemical composition.

Source: ScienceWise Magazine, May/June 2009 Edition, sciencewise.anu.edu.au/articles/skymapper www.mso.anu.edu.au/skymapper/news.anu.edu.au/?p=14301

Maia Detector

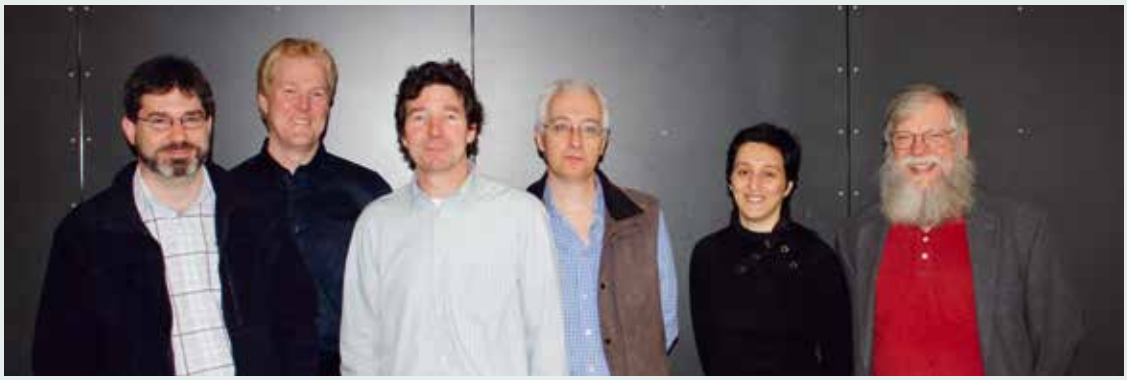
The Maia X-ray Microprobe Element Imaging System developed by CSIRO and Brookhaven National Laboratory (BNL) in New York has won a prestigious R&D 100 Award.

Convened by the United States-based R&D Magazine, the annual R&D 100 Awards recognise the 100 most technologically significant products from around the world introduced into the marketplace in the past year.

The Maia system is a high-throughput X-ray fluorescence detector system which – when combined with a focused X-ray source such as the Australian Synchrotron's X-ray Fluorescence Microprobe (XFM) beamline – is able to produce high-definition, quantitative elemental images with microscopic or nanoscopic detail in real-time.

The project had ARC LIEF funding support and is a collaboration between:

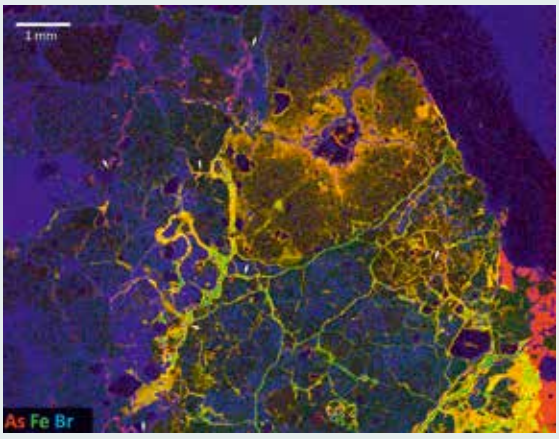
- Earth Science and Resource Engineering: bringing expertise in X-ray fluorescence techniques for mineral analysis led by Chris Ryan
- Materials Science and Engineering: bringing expertise in detector integration and high-speed embedded software led by Gareth Moorhead
- The Detector group from The National Synchrotron Light Source (NSLS) at BNL: led by Peter Siddons.



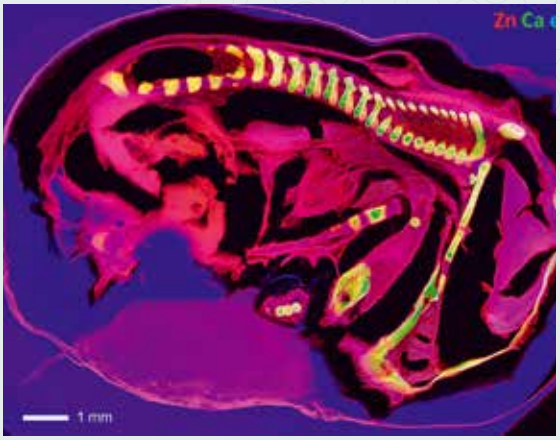
Members of the Maia team. (L-r) Robin Kirkham (CSIRO Materials Science and Engineering), Dr Chris Ryan (CSIRO Earth Science and Resource Engineering), Dr David Paterson (Australian Synchrotron), Dr Gareth Moorhead (CSIRO Materials Science and Engineering), Gabriella Carini (Brookhaven National Laboratory) and Pete Siddons (Brookhaven National Laboratory). Image by Nancy Mills, Australian Synchrotron

"The Maia system allows samples to be scanned up to 1000 times faster and in much greater detail than previous methods. It uses its large detector array and real-time processing capacity to map trace elements very rapidly at micron resolution and over centimetre scales including whole geological thin sections", said Chris.

"Maia harnesses the power of CSIRO's Hybrid Modular Processor System, an embedded computer platform using mathematical methods for spectral de-convolution. It represents a fresh approach to fluorescence imaging."



Maia RGB image (As, Fe, Br) of calcrete from Mount Gibson gold deposit, Western Australia. Chris Ryan, CSIRO.



Maia RGB image (Zn, Ca, scattering) of a mouse embryo cross-section. Euan Smith and Enzo Lombi, CRC Care

Peter Siddons explained that the Maia method allows users to scan a sample continuously along a line. "The exposure is just a few milliseconds at each point so it never really stops moving. However, we collect full spectral data as we go. That not only makes it fast, but allows for high-quality quantitative analysis as well", he said.

Development of a Maia detector for the XFM beamline was commissioned by the Australian Synchrotron in 2008 and it has been providing high-definition elemental images of complex natural samples since its delivery in March 2010. Maia detectors are currently in service at the Australian Synchrotron and the NSLS to aid research in the biological, geological, materials and environmental sciences, medicine and cultural heritage.

Future directions in the Maia project look towards enhanced capabilities, commercialisation and further Maia installations in major facilities around the world.

Website for further information:
www.csiro.au/Outcomes/Materials-and-Manufacturing/Maia-x-ray-microprobe-elemental-imaging-system.aspx

Vaxsafe® MG and Vaxsafe® MS

Diseases caused by mycoplasmas create significant problems for animal health, welfare and productivity. Treatment and prevention of these diseases are a considerable cost to agricultural production and a major reason antibiotics are used in agricultural animals. Novel vaccines for poultry mycoplasmas have been developed over a twenty year period in a collaborative effort between the Asia-Pacific Centre for Animal Health at The University of Melbourne and the Australian company Bioproperties Pty. Ltd.

Vaxsafe® MG and Vaxsafe® MS are live attenuated vaccines providing protection against the two different species of mycoplasmas causing chronic respiratory disease and other syndromes in poultry. The diseases caused by these pathogens result in significant production losses.

The impact of Vaxsafe® MG and Vaxsafe® MS on animal and public health has been to greatly enhance control of respiratory diseases in poultry. This has led to greatly reduced reliance on antibiotics for control of these diseases and over a 90% reduction in the use of macrolide antibiotics in poultry, as well as providing much more effective and economic control of these important diseases than had previously been possible.

The collaboration has also lead to the joint development of additional vaccines to control other significant diseases of poultry and pigs, as well as a continuing programme of research aimed at developing new applications for these vaccines, and to collaborations with other companies to develop vaccines to control diseases of other animals.

Websites for further information:
research.vet.unimelb.edu.au/apcah/index.html
www.bioproperties.com.au/index.htm
www.poultex.com/news.asp?article=10414
www.usaha.org/Portals/6/Reports/2009/report-pad-2009.pdf

CHAPTER 3

Skills and innovation

The importance of skills to innovation and productivity

Productivity growth will increasingly occur through people working smarter rather than just harder.[99] An educated and skilled workforce is essential for successful innovation because it is more likely to be able to generate and implement new ideas and to adapt to new technological and organisational change originating from elsewhere.[100] Because innovation occurs throughout the economy and in all stages of production and distribution, the skills needed are wide-ranging. Strong technical skills such as trades, design and engineering may be necessary for creating, developing and diffusing many new technologies, products and processes, but also important are the management skills needed to adopt and adapt innovations.[101] The relationship between innovation and skills is a virtuous cycle in the long term. The skills of the workforce and management determine the innovation that takes place, which then determines the demand for skills, which again influences innovation and so on.[102] The data in this chapter describes evidence of this virtuous cycle.

Improved cognitive skills derived from higher educational achievement leads to significantly greater economic growth.[103] Both the quality of education and its quantity contribute to this growth. More specifically, the OECD[104] and others have found that increasing broad-based education and training outcomes has a significant impact on Australia's productivity growth.[105] The Productivity Commission highlights international studies showing that an additional year of education can raise the level of productivity by 3% to 6% for a country like Australia.[106] A recent report for the Australian Government shows that an 8% increase in bachelor degree attainment and 11.8% increase in Certificate III-Advanced Diploma qualifications could result in a 2.5% and 1.5% increase in labour productivity, respectively in the medium term.[107]

This chapter discusses trends in Australia's skill base and provides a number of case studies and a feature on the relationship between skills, innovation and productivity. There are significant numbers of government skills development and education policies and programs across Australia. Updates to many of these policies and programs can be found in the online companion report at www.innovation.gov.au/AISreport2012/program_compendium. More detail on the compendium can be found in Appendix 1.

99 Productivity Commission (2009) *Submission to the House of Representatives Standing Committee on Economics: Inquiry into Raising the Level of Productivity Growth in Australia,* September.

100 OECD (2011) *Skills for Innovation and Research, OECD, Paris;* Jones B & Grimshaw D (2012) *Training and skills to improve innovation in firms,* Manchester Institute of Innovation Research report for the National Endowment of Science, *Technology and the Arts;* Australian Workforce and Productivity Agency (2012) *Future focus: Australia's skills and workforce development needs,* A discussion paper for the 2012 National Workforce Development Strategy, July.

101 Department for Business, Innovation and Skills (2011) *Innovation and Research Strategy for Growth,* BIS Economics Paper No. 15, London; Innovation Business Skills Australia (2009) *Developing Innovation Skills: A guide for trainers and assessors to foster the innovation skills of learners through professional practice*.

102 Tether B, Mina A, Consoli D & Gagliaardi D (2005) *A literature review on skills and innovation. How does successful innovation impact on the demand for skills and how do skills drive innovation?* CSIC report to the Department of Trade and Industry, UK.

103 Hanushek E & Woessmann L (2010) *The High Cost of Low Educational Performance: The Long-Run Economic Impact of Improving PISA Outcomes,* OECD, Paris.

104 OECD (2006) *Sources of Knowledge and Productivity: How Robust is the Relationship?,* STI Working Paper 2006/6, Paris.

105 OECD (2006) *Sources of Knowledge and Productivity: How Robust is the Relationship?,* STI Working Paper 2006/6, Paris; KPG Econtech (2010) *Measuring the Impact of the Productivity Agenda,* final report commissioned by the Australian Government, May; Eslake S & Walsh M (2011) *Australia's Productivity Challenge,* Grattan Institute Report No. 2011-1 February.

106 Productivity Commission (2007) *Potential Benefits of the National Reform Agenda,* Research paper, Canberra.

107 KPG Econtech (2010) *Measuring the Impact of the Productivity Agenda,* final report commissioned by the Australian Government, May.

FEATURE: SKILLS AND THE PRODUCTIVITY CHALLENGE

Tom Karmel

Managing Director
National Centre for Vocational Education Research

Skills are typically acquired from formal education, general life experience and learning on the job. However, when policy makers talk about 'skills' they generally are referring to the skills obtained in formal education. Often qualifications and education levels are used as a proxy for skills, for the simple reason that they can be quantified. Thus when governments have designed policies to increase skill levels, they are usually couched in terms of qualifications. So we see that the Australian Government has set targets such as '40% of 25-34 year olds will have a degree by 2025' and 'there will be a doubling of diploma completions from 2009 to 2020' (Australian Government, 2009; COAG, 2012).

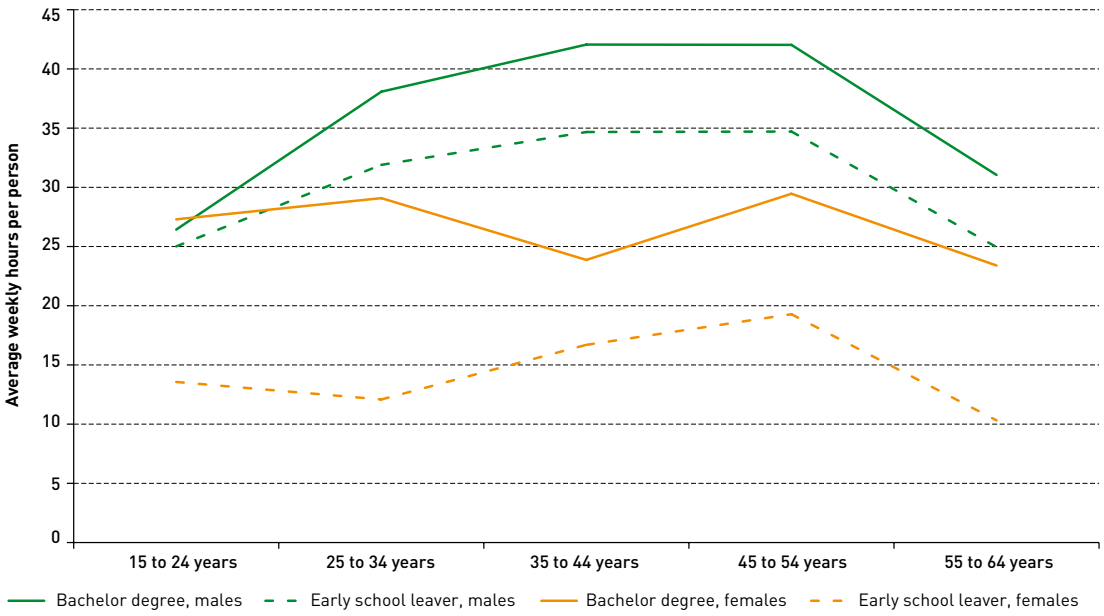
While no doubt education and training is a good thing in its own right, the motivation for increasing skill (qualification) levels is that it will have a positive impact on productivity and hence living standards. In fact, increasing skill levels also has an indirect effect on living standards through the impact on labour force participation. This is because those with higher levels of education have on average considerably higher labour force participation rates. These participation rates translate to higher levels of economic activity and hence overall living standards; there are more workers and fewer dependents. Ken Henry (2007) talked about the three Ps- productivity, participation and population (see also Chapter 7 of this report). Increased population will also lead to higher levels of economic activity, but this will only flow through to higher living standards if there are economies of scale. However, there is little ambiguity about the direction of the impact of increased education levels on productivity and participation.

The impact of education levels on participation is straightforward. Those who are better educated find it easier to get jobs, and better/higher paid jobs. They also tend to work longer hours (in particular more full-time jobs and less part-time jobs). Therefore an increase in education levels will result in an increase in the labour supply, everything else remaining the same (Figure F3.1). The increase in labour supply due to this effect was a little over 3% (measured in annual hours) between 2001 and 2009 (Karmel, forthcoming).

The impact of education levels on productivity is a little more complicated. There are two channels here. The first is that better educated people are more skilled, and this is reflected in higher relative wages. So an increase in the proportion of people with qualifications will flow through to an improvement in the quality of labour – for the same number of hours worked the economic output will be higher.

The second channel is a little more subtle. In a world with no innovation, output can increase only if there is an increase in factor inputs (notably labour and capital) or the quality of these inputs. However, with innovation more can be produced with the same inputs. In such a world, increased skills may have a role in driving innovation. Technology – the methods of production - may be 'endogenous' (i.e. affected by the economy rather than something that is fixed), and education levels may be one of the influencers. For example, van Zon (2001) constructs a model in which highly skilled labour can be directed to either R&D or as an input into final output production. If skilled labour is directed to the former then the economy's productive potential expands, and the demand for skilled labour can increase. If it is directed to the latter then the economy will grow because of an improvement in the quality of labour, but eventually will hit a limit as the marginal product of skilled labour falls to that of unskilled labour (for example, research graduates driving taxis). In such a world the demand for skilled labour essentially remains static, and so an expansion in the number of skilled people leads to a decline in their wages.

Chart F3.1: Average weekly hours per person for selected educational qualifications, by sex and age, 2009



Source: ABS (2009) *Education and Training Experience, 2009*, basic and expanded curf, cat. no. 6278.0.

Thus we have two theoretical frameworks in which to think about the impact of increasing education levels on productivity.

In van Zon's model, the mechanism for innovation and growth is through R&D. However, the process for innovation is much broader than conventional R&D. The Australian Bureau of Statistics (2010) defines it as 'The introduction or implementation of a new or significantly improved good or service, operational process, organisational managerial process or marketing method'. It does not have to be radical; much is incremental in nature, and it can occur in any sector of the economy. The skills required for innovation go far beyond scientific, engineering and design skills. Indeed, ABS (2010) data show that the difference in skill usage between innovation active businesses and non-innovation active businesses is greatest in marketing skills. And this holds true in most industries: manufacturing; professional, scientific and technical services; finance and insurance, wholesale trade; and retail trade. Marketing loses its pre-eminence as a marker of innovation only in mining (where the greatest difference in skills usage between innovative and non-innovative businesses is in engineering and trades skills).

Stanwick (2011), in his review of the literature, notes that the link between skills for innovation and formal training is complex. Toner (2011) argues that problem solving skills are important for incremental innovation although elite technical skills may be required for radical innovations. Similarly, Dalitz, Toner and Turpin (2011) argue that education and training needs to provide the ability to learn, to adapt to change, and to be creative. As an aside, these ideas throw up a challenge for the vocational education and training sector in particular because of that sector's emphasis on competencies. We also need to note that innovation, as Stanwick puts it, 'does not imply an ever-increasing demand for more and higher levels of qualification'. It is often aimed at reducing the need to employ skilled (well paid) labour. One example is that modern cars require much less servicing than used to be the case, and many repairs are effected by replacing rather than repairing components.

Skills are obviously linked with productivity and most of the arguments presented above are consistent with the notion that an increase in skills will improve productivity. Therefore an obvious place to end is with an estimate of how increasing skill (education) levels have improved productivity. I have estimated that over the period 1968-69 to 1989-90 that the quality of labour increased by 13% due to improving levels of education (Karmel, 1995, p87). That is, the quantity of labour could have been reduced by 13% without affecting overall economic output. An alternative interpretation is that the change in the educational structure of the workforce explained around 0.4 percentage points of the multi-factor

productivity improvement of 1.4% per year between 1968-69 and 1989-90. I have updated my earlier estimates (Karmel, forthcoming) and estimated that the quality of the labour increased by around 2.6% between 2001 and 2009 due to increasing levels of education. This equates to a little under 0.2% per annum contribution to multifactor productivity, about half of the corresponding contribution for the earlier period.

Since 2001 the ABS (2001, 2011) has published experimental estimates in multi-factor productivity that allow for changes in the quality of labour. The adjustments reflect more than just changes in educational levels because they also allow for changes in the average experience of the workforce. According to the Australian Bureau of Statistics multifactor productivity peaked in 2004 (irrespective of any adjustments for the quality of labour). The labour quality adjustments imply that between 1995 and 2004, the changes in education levels and average work experience explain about 0.36% per annum of the increase in multifactor productivity. The corresponding estimate for the period 2004 to 2011 is 0.2% per annum, a number similar to my calculations for 2001 to 2009. Since 2004 the increase in productivity due to increasing education levels has not been able to offset the decline in productivity due to other factors.

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Australia's skills base

The term 'national innovation system' acknowledges that *innovation is about people*: the knowledge, technology, infrastructure, rules and cultures they have created or learned; who they work with; and what new ideas they are experimenting with. It is therefore important to look at where bottlenecks in supply and demand of skilled people may be occurring. Lack of skilled people has been the highest single reported barrier to innovation in Australian businesses in recent years (Chapter 1; Chart 1.6) while this barrier to innovation is declining as the working population becomes more skilled (Table 3.1).

An important indicator of the adequacy of national education policy for skills development is a country's expenditure on tertiary education. Tertiary education describes both higher education, with its emphasis on theoretical knowledge, and vocational education and training (VET) which focuses on practical, technical or occupational skills for direct entry into the labour market.[108] Education expenditure measures the input to skills acquisition. The "output" of education is the knowledge and skills acquired by the student. Data on qualifications are generally used as a proxy measure of this output. Table 3.1 shows Australia's expenditure on tertiary education (higher education and some VET) was 1.62% of GDP in 2009. Australia ranked 11th out of 31 OECD countries on this measure, ahead of France, Japan and Germany. The top five countries, USA, South Korea, Canada, Chile and Finland averaged 2.40% in 2009. Most of the leading countries on this measure tend to have education systems which feature a significant role for privately funded tertiary institutions.

Historically, however, tertiary education throughout most of the world has been publicly funded to make it accessible to the wider population. Australia's public expenditure on tertiary education as a share of GDP

108 OECD (2011) *Education at a Glance 2011*, Paris, p.27.

fell to 1.1% in 2009, down 2.0% since 2006, ranking it 20th in the OECD, just over half the amount spent by New Zealand (5th). Nordic countries: Denmark, Norway, Finland and Sweden invested heavily in tertiary education from the public purse. The top five countries' average expenditure was 2.2% of GDP.

The Australian Workforce and Productivity Agency (formerly Skills Australia) has argued that if demand for skilled labour is to be met and potential constraints on economic growth avoided, investment is needed to allow for a 3% per annum growth in tertiary graduates to 2025.[109] Other issues identified included the need to: improve literacy and numeracy; raise participation levels to 69% by 2025; and make better use of employee skills. These issues and others will be revisited in the upcoming National Workforce Development Strategy, which will be provided to the Government in December 2012.

The proportion of Australia's population aged 25-64 attaining a tertiary education qualification has increased by 13.9% since 2006 to 37.6% in 2010, ranking Australia 9th in the OECD. The leading countries: Canada, Israel, Japan, USA and New Zealand averaged 44.7%. Australia also ranked 8th in the proportion of its 25-34 year olds attaining a tertiary education. The 14.4% increase in educational attainment of this younger demographic since 2006 indicates the country's future skills capability is growing.

Although Australia ranked in the top third of OECD countries for its PhD graduation rate, this has not grown since 2007, after increasing 41% between 2000 and 2005. The number of students completing a higher degree by research (HDR) in Australia increased by 4.3% to 7,401 in 2010. This growth was largely attributable to the 13.5% increase in the number of international students completing a HDR. Domestic student HDR completions have shown little growth over the same period.

Other indicators of the skills base in Table 3.1 suggest that quantitatively, Australia has a research and professional workforce that is slightly above the OECD average in terms of R&D personnel as a percentage of total employment, researchers as a percentage of the total labour force and the share of professionals and technicians in total employment. Analysis of the health of Australia's science system undertaken recently[110] concluded that education systems produce graduates in many of the areas of need but that we have issues with:

- declining secondary school participation rates in the enabling subjects of mathematics, chemistry and physics;
- looming shortages of capability as a consequence of the ageing academic staff profile; and
- a gender imbalance in the enabling sciences[111], with women accounting for smaller percentage shares in scientific careers and at senior academic levels.

Measuring the quality of the skills base is more difficult. Ideally, direct measures of the advanced conceptual, analytical, communication and problem solving skills that students might be expected to develop during the course of their degree would allow some assessment of skills, but such measures are still under development and no internationally comparable metrics are yet available.[112]

109 Skills Australia (2010) *Australian Workforce Futures: A National Workforce Development Strategy; and Skills Australia (2011) Skills for Prosperity: A road map for vocational education and training*

110 Office of the Chief Scientist (2012) *Health of Australian Science*, p.5.

111 Mathematics, physics and chemistry.

112 The OECD's feasibility study, *Assessment of Higher Education Learning Outcomes (AHELO),* is exploring whether it is possible to measure and draw discipline specific and generic comparisons internationally of what students know and can do as a result of studying for bachelor level qualifications. See: http://www.oecd.org/document/22/0,3746,en_2649_39263238_40624662_1_1_1_1,00.html [Accessed 20 September 2012].

Table 3.1: Australia's skill base compared to other OECD countries

Indicators	2006	2007	2008	2009	2010	2011	OECD average (latest year)	OECD top five average (latest year)	Gap from the top 5 OECD performers (latest year)	Ranking against OECD countries (latest year)	Change from baseline year to latest year (Baseline in bold)
Tertiary education expenditure as a % of GDP[1[r]]	**1.6**	1.5	1.5	1.6	-	-	1.6	2.4	33%	11th	-1.0%
Public expenditure on tertiary education as a % of GDP[1[r]]	**1.1**	1.0	1.0	1.1	-	-	1.4	2.2	49%	20th	-2.0%
Proportion of population aged 25-64 attaining below upper secondary school education[1[r]]	33.3	**31.8**	30.1	29.0	26.8	-	26.0	10.1	-166%	21st	-16%
Proportion of population aged 25-64 attaining upper secondary school education (%)[1[r]]	33.7	**34.4**	33.8	34.1	35.6	-	43.8	67.8	47%	27th	3.4%
Proportion of population aged 25-64 attaining tertiary education[1[r]]	33.0	**33.7**	36.1	36.9	37.6	-	30.3	44.7	16%	9th	11%
Proportion of population aged 25-34 with tertiary education[1[r]]	38.8	**40.7**	41.7	44.8	44.4	-	37.8	54.7	19%	8th	9.0%
Number of students completing higher degree by research in Australia*[2]	7,094	7,135	**7,174**	7,091	7,401	-	n/a	n/a	n/a	n/a	3.2%
PhD graduation rate (%)[1]	**1.89**	1.91	1.89	1.85	-		1.52	2.84	35%	9th	-2.2%
Share of professionals and technicians in total employment (%)[3]	37.6	-	**35.8**	-	36.1	-	31.8	42.4	15%	9th	1.0%
R&D personnel as a % of total employment[4[r][nd]]	**1.2**	-	1.3	-	-	-	1.2	1.8	32%	14th	2.1%
Researchers as a % of total labour force[5[r][nd]]	**0.8**	-	0.8	-	-	-	0.7	1.2	32%	12th	0.5%
Local availability of specialised research and training services[5[y]]	5.2	**5.3**	5.3	5.3	5.4	5.3	5.1	6.1	13%	14th	No change
Lack of skilled persons in any location as a barrier to innovation[6[ea]]	25.7	**23.0**	19.4	20.4	20.0	-	n/a	n/a	n/a	n/a	-13%

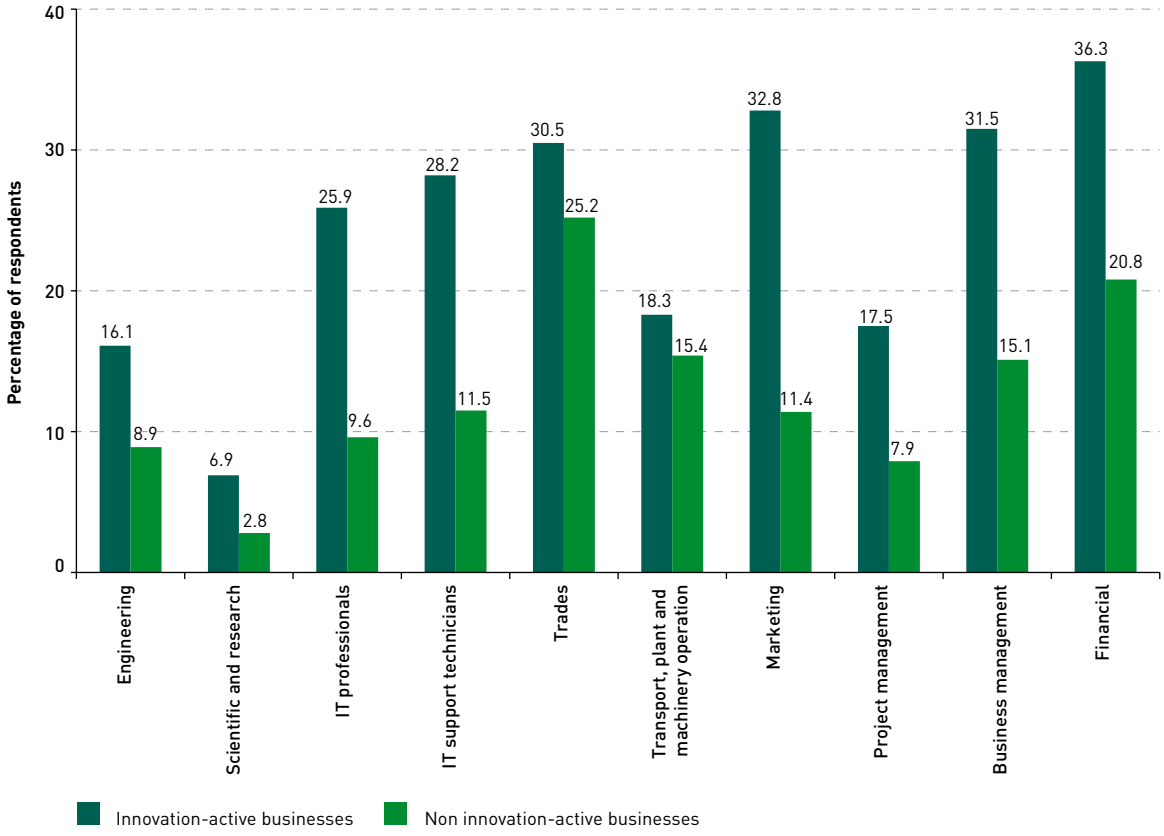
Sources:
1 OECD (various) *Education at a Glance 2007, 2008, 2009, 2010, 2011, 2012* OECD, Paris.
2 DIISRTE (2012) Analysis of higher education statistics - unpublished data.
3 OECD (2011), *OECD Science, Technology and Industry Scoreboard 2011*, Paris.
4 OECD, *Main Science and Technology Indicators* database, 2012/1.
5 World Economic Forum, *The Global Competitiveness Report 2007-08, 2008-09, 2009-10, 2010-11, 2011-12*, and *2012-13*.
6 ABS (various) *Business Characteristics Survey 2006-07, 2007-08, 2008-09, 2009-10*, cat. no. 8167.0.

Notes: Indicators with * and in the highlighted rows of the table are the primary indicators applied to measure and monitor progress against the Australian Government's innovation targets. (a) OECD rankings are performed on those OECD countries for which data is available. Individual data availability may vary between indicators. Rankings from previous reports have been revised and may vary as a result. [r] The data may have been revised according to the latest available data. [nd] No new data. [n/a] not available. [-] not applicable. [y] Data is as at earliest year in publication date i.e. 2011 data is from the year 2011-2012 WEF Publication. [ea] ABS 8167.0 data prior to 2009-10 excludes agriculture.

Chart 3.1 shows that the skills most used by innovation-active businesses in 2010-11 were business management, financial, marketing and trades skills. Science and research skills remain the lowest reported skills used by innovators. The most pronounced differences in skills used between innovation-active and non innovation-active businesses were in marketing, scientific and research, and information technology professionals and technicians. Innovative Australian businesses were more than twice as likely to use business and project management and marketing skills than non-innovators.

Many of the skills used by innovation-active businesses (Chart 3.1) are acquired in the VET sector or through workplace training as much or more than higher education studies. However, businesses that produce innovations which are new to the international market report a much greater usage of scientific and research and particularly engineering skills (Chart 3.2). This data is consistent with the low proportion of new-to-the-world innovators in Australia compared to other countries[113] and the low number of researchers working in businesses.[114] Underlying this may be structural trends such as a high proportion of SMEs. This data suggests a low level of cross fertilisation and knowledge exchange compared to other notably more innovative countries (see further discussion in Chapters 4 and 5).

Chart 3.1: Skills used in undertaking core business activities by innovation-active and non innovation-active businesses, 2010-11

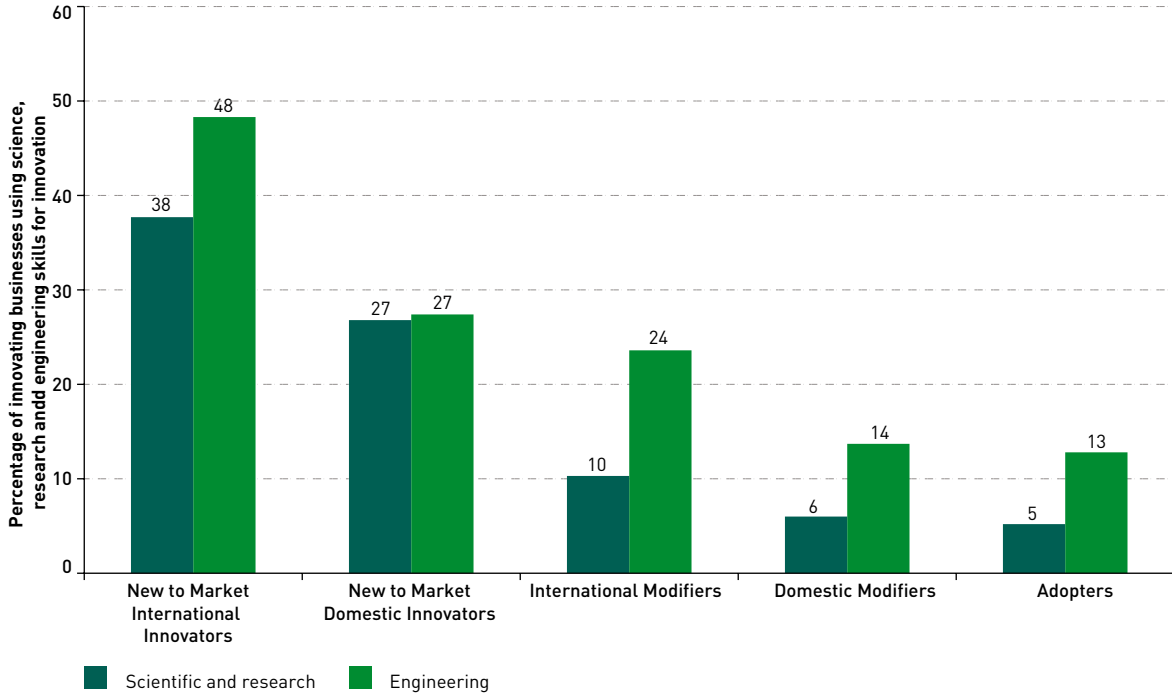


Source: ABS (2012) *Selected Characteristics of Australian Business, 2010-11,* cat. no. 8167.0

113 See *Australian Innovation System Report – 2011*, p.23.

114 Pettigrew AG (2012) *Australia's position in the world of science, technology and innovation*, Australian Chief Scientist Occasional Paper Series, Issue 2, May.

Chart 3.2: Modes of innovator by types of skills used, 2008-09



Source: ABS *Business Characteristics Survey* – DIISRTE special data request.

Skill shortages

In periods of low unemployment skill shortages are always an issue. The national rate of unemployment has fallen since the global financial crisis of 2007-08, from its 5.9% peak in June 2009 to 5.1% in August 2012. At the same time, job losses are occurring in manufacturing, media and public services, among others, attrition that could be associated with a broader trend of significant structural transformation of Australia's economy. Skills shortages are defined by the Department of Education, Employment and Workplace Relations (DEEWR) as the proportion of employer vacancies that are unfilled. However, it is important to distinguish the different concepts of *shortages*, *gaps* and *recruitment difficulties* surrounding the notion of skills shortages, as the ABS has done.[115]

In 2011 the most acute skills shortages reported by DEEWR were in engineering professions, automotive trades, resource sector professions and associates and social professions. Shortages were most severe in Western Australia, the Northern Territory and the Australian Capital Territory. [116]

Overall, the data suggests skill shortages in 2011-12 are not as serious as in 2007-08 before the global financial crisis. Yet a report on skills use in the years immediately before the outbreak of the financial crisis challenged the commonly held belief that Australia's economic performance was hampered by a critical shortage of skills, finding that only about 15% of employers reported a lot of difficulty in recruiting staff and attributed this to a shortage of skills in their industry.[117] On the contrary, it found 37% of employers reported that their employees had skill levels above what the employer required and only 5% reported employees having skill levels below what was required.

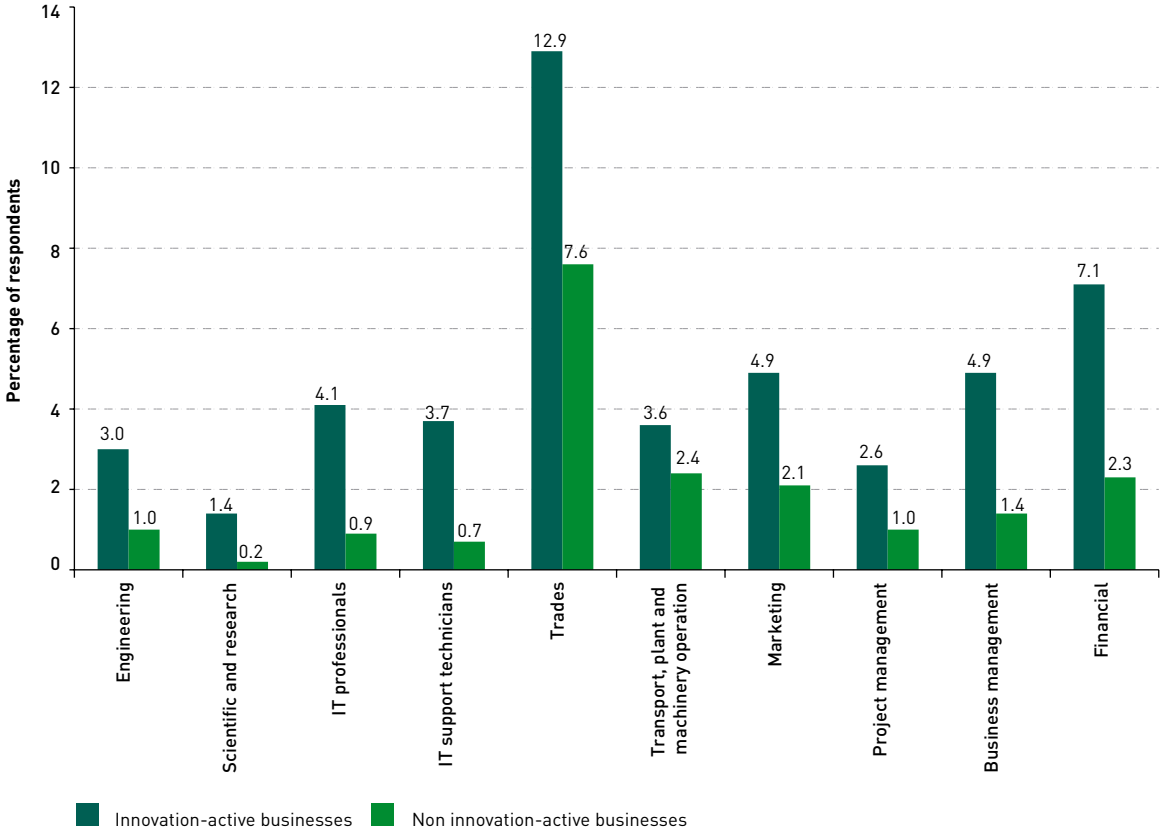
Skills shortages are more likely to be reported by innovative businesses than non-innovative businesses across all skills categories (Chart 3.3). The highest reported skill shortage was trade skills followed by marketing, financial and management skills. Interestingly scientific and research and IT skill shortages are four to seven times higher for innovators. Innovative Australian businesses are also two to three times more likely to report shortages in management, marketing and financial skills than non-innovators.

115 ABS (2006) Skills Shortages in Western Australia: Part 1, In *Western Australian Statistical Indicators, Dec 2005,* cat. no. 1367.5.

116 DEEWR (2011) *Skill Shortages – Summary 2011*, Department of Education, Employment and Workplace Relations, Canberra.

117 Watson I (2008) *Skills in Use: Labour Market and Workplace Trends in Skills Usage in Australia,* NSW Department of Education and Training on behalf of DEEWR.

Chart 3.3: Skills shortages or deficiencies in undertaking core business activities reported, by innovation status, 2010-11



Source: ABS (2012) *Selected Characteristics of Australian Business, 2010-11*, cat. no. 8167.0.

Better use of existing skills

While skills development is important, how employee skills are used in the workplace is also important in achieving innovation and productivity improvements.[118] Skills utilisation is concerned with maximising the contributions that people can make in the workplace and the extent to which people's abilities are 'deployed, harnessed and developed to optimise organisational performance'.[119] To an extent this is dependent on the management quality of Australian businesses.

Strategies that help to maximise employee capability and skills utilisation include job redesign, employee participation, autonomy, job rotation and knowledge transfer (mentoring and applying new skills in the workplace). These strategies can result in innovation, increased productivity, better retention and decreased work related injuries. Critical success factors underpinning effective use of these strategies include: supportive leaders and managers; communication, consultation and collaboration; good human resources practices, a supportive organisational culture and inclusive workplace; and motivated employees that feel valued.[120] However, it has been argued that there is scope for improving leadership and management skills to bolster Australia's innovative capacity.[121] Chapter 1 provided evidence that suggests Australia's management capability is behind other advanced OECD countries. It is notable that out of all aspects of management, Australian businesses appear to be below average with regards to people management[122] and innovation culture (see Chapter 4). The data provided in Chart 1.3 and 3.4, taken together, suggests that innovative businesses tend to have a higher organisational and management capability sufficient to drive productivity growth particularly in SMEs.

118 UK Commission for Employment and Skills (2010) *High Performance Working: A Policy Review,* Evidence Report 18, London, p.3.

119 Skills Australia (2012) *Better use of skills, better outcomes: A research report on skills utilisation in Australia*.

120 *Ibid*.

121 Australian Workforce and Productivity Agency (2012) *Australia's skills and workforce development needs, discussion paper for the 2012 National Workforce Development Strategy,* July.

122 Australian Institute of Management (2012) 2012 *Australian Management Capability Index*, http://www.aim.com.au/resources/AIM-AMCI.pdf [Accessed 30 August 2012].

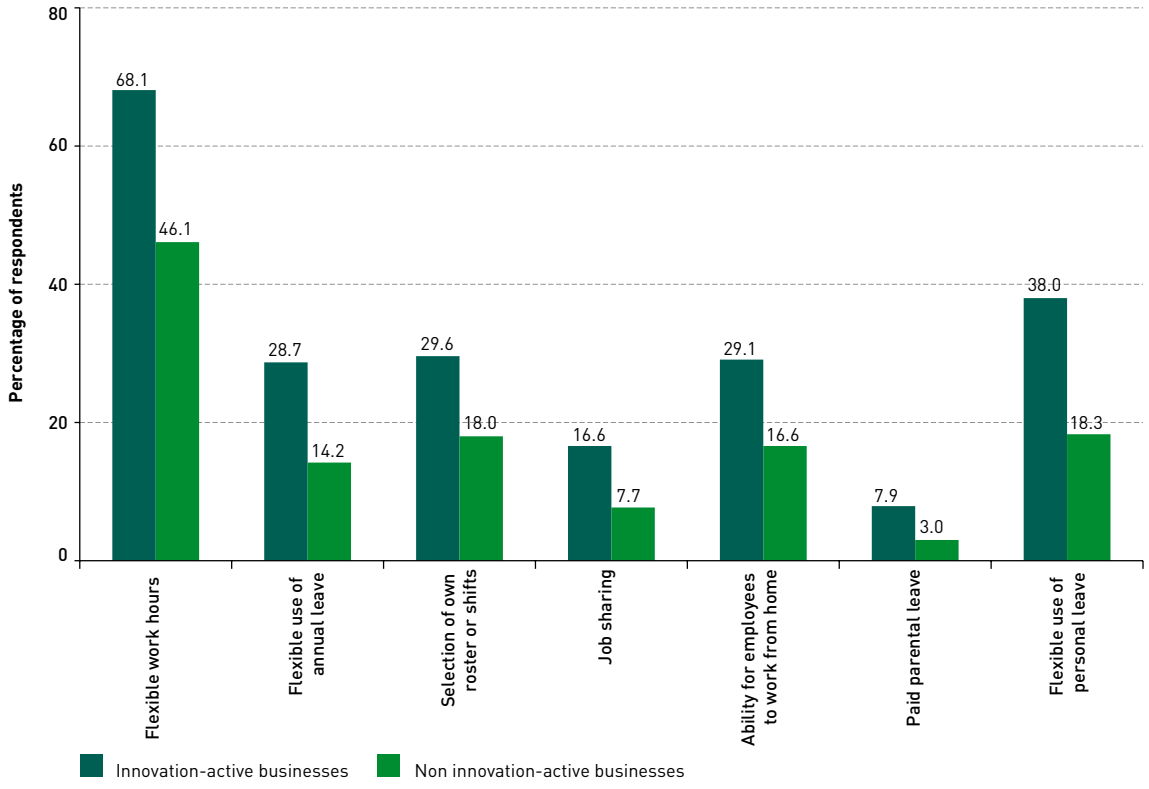
Training and working arrangements

The amount of training available to workers is an essential element for improving productivity and innovation.[123] Chapter 1 shows very clearly that innovative businesses are more than three times more likely to increase training for employees than non-innovators (Chart 1.2). This has significant implications for the skills development of employees and demand-side labour market flexibility.

Labour market flexibility can separate businesses, sectors and economies with the same underlying capacity for idea generation by enabling a more rapid allocation of skilled labour to the most promising market experiments.[124] The 'rigidity of employment' index measures the regulation of employment, specifically the hiring and firing of workers and the rigidity of working hours.[125] By this measure, Australia, Hong Kong, Singapore, and the USA have the most flexible labour arrangements (equally ranked).

In practice, labour market flexibility is two-sided, particularly in a 'full-employment economy'. Businesses have to provide opportunities to deepen skills on the job and accommodate flexible working arrangements themselves in order to retain the people they need.[126] Chart 3.4 shows that innovative businesses are much more likely to introduce flexible working arrangements than non-innovative businesses. So, not only are innovative businesses more than twice as likely to increase employment than non-innovators in any given year (Chart 1.3), but they also are more likely to increase training opportunities and introduce more flexible working arrangements for employees encouraging greater labour force participation. The evidence points to a virtuous cycle between innovation, employment and skills development. A culture of innovation generates more flexible employment opportunities for skilled people. In turn these people help businesses to innovate, generating higher productivity, income and supernormal profit streams from a greater range of goods and services (see Chapter 1 and 4). It is not hard to see that an innovative business becomes synonymous with a high quality business. These results warrant further exploration.

Chart 3.4: Employee working arrangements by innovation-active and non innovation-active businesses, 2010-11



Source: ABS (2012) *Selected Characteristics of Australian Business*, 2010-11, cat. no. 8167.0

123 Billett S et al (2012) *Change, work and learning: Aligning continuing education and training,* NCVER working paper.

124 Bartelsman E, Scarpetta S & Schivardi F (2005) Comparative analysis of firm demographics and survival: Evidence from micro-level sources in OECD countries, *Industrial and Corporate Change* 14: 365–391.

125 World Bank/International Finance Corporation (2009), *Doing Business 2010: Reforming through Difficult Times.* Rigidity of Employment Index on a 0–100 (worst) scale in 2009. This index is the average of three subindexes: Difficulty of hiring, rigidity of hours, and difficulty of firing. The three subindexes have several components and all take values between 0 and 100, with higher values indicating more rigid regulation.

126 Buchanan J (2011) Productivity and labour - four paradoxes and their implications for policy, in *Work and employment relations: an era of change* (Ed. Baird M, Hancock K & Isaac J).

Innovation skills development

Innovativity is a practical innovation management program for Australian organisations developing innovative products and services. The program is run by the Advanced Manufacturing CRC with the objective of helping Australian businesses profit through innovation by raising innovation management capability.

Geoff Lowe, MIL-Systems

In 2011, four programs were held in Melbourne (2), Sydney and Brisbane. Overall 92 participants have attended the program. Each program was facilitated by world-class experts with decades of innovation experience bringing with them a wealth of experience ranging from Australian success stories, Silicon Valley start-ups and global organisations. Innovativity has eight more sessions planned for the 2012-13 financial year.

Innovativity participants gained comprehensive innovation skill development, easy to apply systems and processes and relevant tools and templates. Using a unique diagnostic tool, Innovativity identified gaps in each participant's innovation capability and pinpointed specific areas of focus for them to apply in their workplace. Components of the program included Business strategy in innovation, maximising intangible assets, pre-empting the market, R&D, maximising innovation value, and creating sustainability.

Engineering manager at Melbourne based power converter manufacturer MIL-Systems, Geoff Lowe, who took part in the Innovativity program, said he understood the importance of intellectual property protection but he needed assistance translating intellectual property into commercial value.

"I was aware of the concepts but I needed help to make [the knowledge] applicable to MIL-Systems," he said.

After attending the Innovativity program, Mr Lowe immediately began implementing the new skills he had developed. Some of the new innovation skills that have improved MIL-System's productivity and business model include:

- Planning and control for rapid prototyping;
- An analysis and management tool to help find development problems e.g. loops caused by decisions made early in development which result in unnecessary repetition of work;
- New marketing skills that help identify the market for a product during the innovation process to help maximize commercial advantage;
- Intellectual property management and negotiation for maximum possible commercial advantage.

Mr Lowe saw the value of the analysis and management tool and immediately trialled in on a small $50,000 project to develop electronics and firmware. MIL-Systems found that the tool was very useful and helped to keep the technical staff on task and the project running on time. In addition, the ability to prototype for maximum value is now something that the company is beginning earlier in the development process and achieving more rapidly.

Website for further information:
www.innovativity.com.au

Building leadership in Australia's construction industry

The Master Builders Association of Victoria's new $14 million Building Leadership Simulation Centre (BLSC) represents a quantum leap for training in the nation's construction industry.

Officially opening in August, the BLSC focuses on improving the leadership, communications, problem-solving and decision-making skills of the nation's construction workforce. Programs target everyone involved in building including project managers, site foremen, sub-contractors, graduates and apprentices. It can assist industry to hone the skills of its leaders and identify potential leaders for the future.

Featuring a 15-metre parabolic screen, 12 construction site sheds and a team of specialist actors, the BLSC immerses participants in scenarios they confront regularly on a real building site. Unlike a real site, at the BLSC there are no risks such as injury, defects, delays or cost overruns.

The screen projects the virtual building site, which has been created by taking 50,000 reference photos from two construction projects in the UK. The Australian Government has provided a further $1.9 million to create local content that can take account of our nation's unique building practices and climatic environment. This funding will be used to recreate projects in both residential and commercial construction. At the same time, actors play the role of stakeholders such as staff, clients and others interact with participants to ensure the challenges they face are as realistic as possible.

The use of simulation training in Europe has helped reduce OHS incidents (precursors to accidents) by up to 90%, improve construction quality by 10% and cut costs by 5%. The technology is being used by many of Europe's biggest building companies and, through the BLSC; it is now available here for local industry.

The BLSC is the first facility of its kind in the Southern Hemisphere and Asia Pacific. In fact, it is just the third of its kind in the world that targets building and construction. A range of courses are available that focus on issues such as workplace safety,

It is designed to show the difference between learning something in a classroom, and applying learning in the noisy, busy, sometimes chaotic environment of a building site. It allows for observing, training and re-training the best actions and reactions of participants.

Trainees receive an interactive and immersive experience being able to 'step into' the construction site through the parabolic screen. Image by Sarah Louise Photography.

The facility has already seen some of Australia's biggest building and construction companies – including Australand, Baulderstone, Metricon and Lend Lease – sign on as foundation partners and committing to train their teams there.

The BLSC will help ensure the construction industry is best placed to deliver the houses, offices, factories, workplaces, schools, hospitals and other social infrastructure Australians rely upon, while supporting innovative skills development for one of the country's largest employment sectors.

RARE – Remote & Rural Enterprise Program – The University of Sydney

The Remote and Rural Enterprise (RARE) Program creates two-way learning and development exchanges between graduate students and enterprises in remote and rural Australia. It is one of the University's flagship ventures that helps integrate its teaching, research and engaged practice within its Innovation & Enterprise Program.

Around 40 of its best students each year are sent all over Australia to support and learn from the initiation and development of remote and rural enterprises. There are dozens of social and commercial enterprises, both indigenous and non-indigenous, participating in the program, including those from Darwin, Tjuntjuntjara, Tuncurry, and Broken Hill.

RARE aims to develop graduates' social and cultural awareness and their entrepreneurial skill set and attributes, while strengthening the network and sustainability of remote and rural enterprises in Australia's more disadvantaged communities. It is the face-to-face engagement, long-term commitment and the collaborative process of exploring, trying and learning that builds the relationships and understanding that will allow RARE to achieve its goals.

Initial efforts have been successful and are now benefitting from many supporters and funders who share the University's vision. The University of Sydney is tracking the medium and long term impact of the engagements from the different perspectives – the students, the academic staff, the enterprise and the community, and look forward to sharing these insights as RARE progresses.

Website for further information:
http://sydney.edu.au/business/innovation_and_enterprise/ventures/RARE

The Green e-waste project in Tuncurry (NSW), April 2012

Acknowledgment: Hannes Rieger (RARE Student)

Broken Hill community gathering (NSW), September 2011

Acknowledgment: Tom Pastro (RARE student)

CHAPTER 4

Business innovation

Business innovation is at the heart of a well-functioning innovation system. Chapter 1 showed that business innovation delivers significant productivity, and other benefits, to Australia. It was also argued that a culture of innovation in the management of businesses is instrumental in achieving these gains. This chapter looks at three dimensions of business innovation in Australia. Firstly, it looks at drivers of innovation and the extent to which we have an innovation culture in Australian businesses. Secondly, it examines key indicators of business innovation performance. Thirdly, it explores how businesses create new business models, innovation strategies and cultures, depending heavily on framework conditions including factors such as buyer sophistication, intensity of competition, absorption of technology, exposure to trade and barriers to entrepreneurship shape businesses' behaviours and decisions.

There are many government programs that support or encourage business innovation across Australia. New policy developments in this area can be found in the program compendium accompanying this report at www.innovation.gov.au/AISreport2012/program_compendium. More detail on the compendium can be found in Appendix 1.

What drives business to innovate?

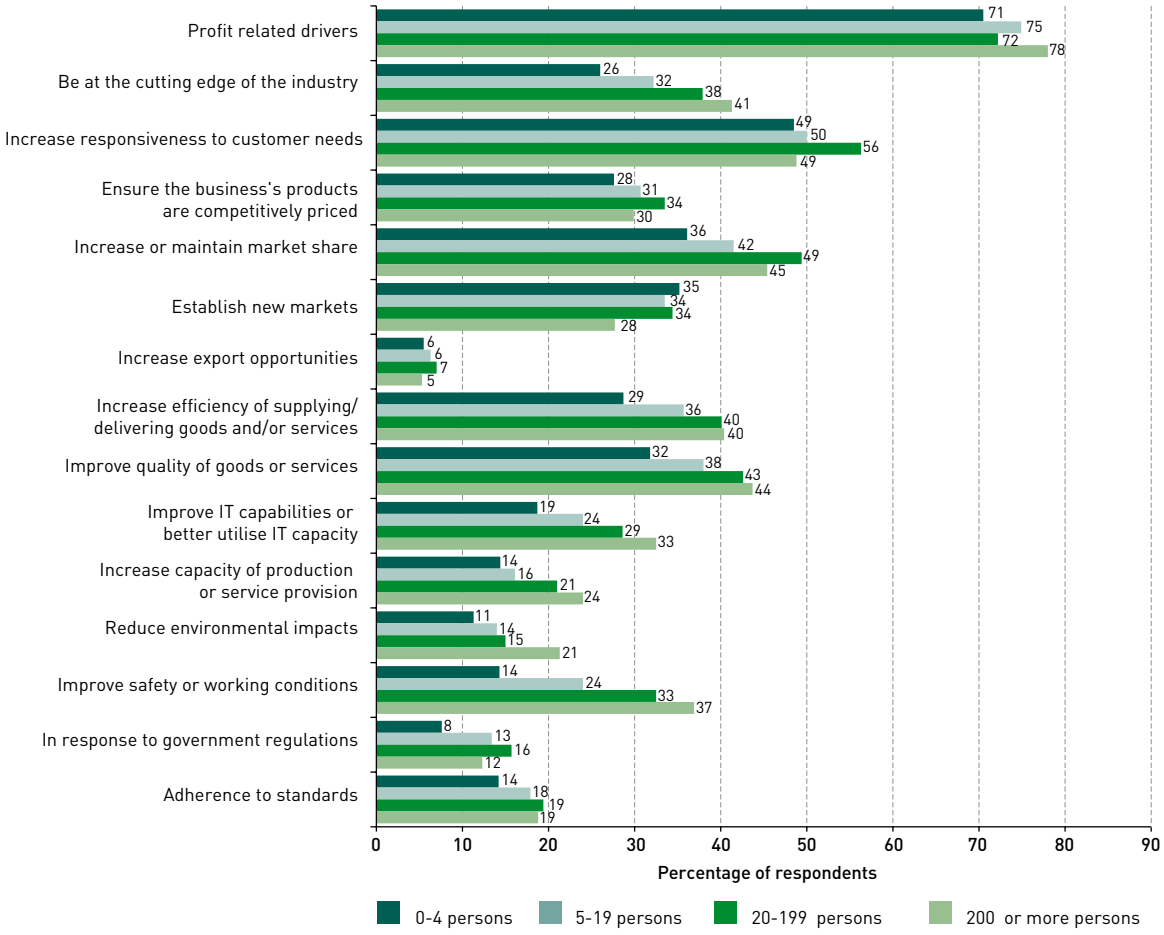
The introduction and Chapter 1 showed that the great majority (>90%) of businesses derive some benefit from innovation and that the productivity benefits are particularly significant. Why then do some businesses and sectors vary in their willingness and/or capacity to innovate? The answer is not simple. Innovation requires *motivation, resources, creativity* and *timing* with management capability central to all these factors. Innovation is not always easy or free. Costs and other barriers to innovation will perhaps always remain to some extent, as innovators push social, environmental and technological boundaries. Not all businesses need to innovate in any given year either. Additionally, businesses that don't innovate in any given year are half as likely to perceive a barrier to innovation than innovators.[127] This suggests that there are differences in the awareness of the challenges and rewards of innovation between those that do innovate and those that don't.

Chart 4.1 explores the motivations behind innovating businesses across Australia. It shows that profit is the single largest driver of innovation at 73% for all innovating businesses. However, businesses usually have more than one objective in mind when innovating. Other drivers of innovation include being more responsive to customer needs (50%), to increase or maintain market share (40%), to establish new markets (34%) or to increase efficiencies (33%) or quality (36%) and being at the cutting edge of the industry (30%). One of the less frequently reported drivers is increasing exports (6%) which may explain why we are not as oriented towards pushing the global innovation boundary as some leading countries.[128] As size increases, businesses are generally more likely to report multiple reasons to innovate. But this is not true in the case of the universal drivers of profit, competitive pricing, increasing export opportunities and establishing new markets (Chart 4.1). Large Australian businesses are significantly more likely than SMEs to innovate to reduce environmental impacts.

127 ABS (2012) *Selected Characteristics of Australian Business, 2010-11*, cat. no. 8167.0.

128 See *Australian Innovation System Report – 2011*, pp.21-23.

Chart 4.1: Drivers of innovation for innovation-active Australian businesses, by business size, 2010-11



Source: ABS (2012) *Innovation in Australian Business*, 2010-11, cat. no. 8158.0.

Innovation culture

A business' culture plays an important role in its decision to invest in innovation and therefore matters for productivity. To a large extent culture is the culmination of business management of human resources, business model design, knowledge management and strategies for absorptive capacity, accounting and measurement management, industrial relationships and leadership.[129] Without leadership, or strategic intent towards innovation, businesses soon become uncompetitive.[130] An innovation culture is associated with a combination of diverse factors such as effective collaboration, openness to new ideas, innovation strategy and embracing and managing technical or commercial risk.[131]

Booz & Company undertook a study of the Global Innovation 1000[132] companies, and found that 44% of businesses had a highly aligned innovation strategy and innovation culture, resulting in higher performance indicators, such as gross profit and enterprise value.[133] This report also indicated that collaboration and openness to new ideas are vital elements of a culture of innovation (see also Chapter 5).

129 Society for Knowledge Economics (2011) *Leadership, Culture and Management Practices of High Performing Workplaces in Australia: The High Performing Workplaces Index,* report to Department of Education, Employment and Workplace Relations, October; Stanwick J (2011) *Innovation: Its links with productivity and skill development,* NCVER, http://www.ncver.edu.au/publications/2424.html, [Accessed 18 September 2012].

130 Tether B, Mina A, Consoli D & Gagliaardi D (2005) *A literature review on skills and innovation. How does successful innovation impact on the demand for skills and how do skills drive innovation?* CSIC report to the Department of Trade and Industry, UK.

131 Australian Industry Group (2010) *Innovation: New Thinking New Directions,* report by the Innovation Review Steering Group, Sydney.

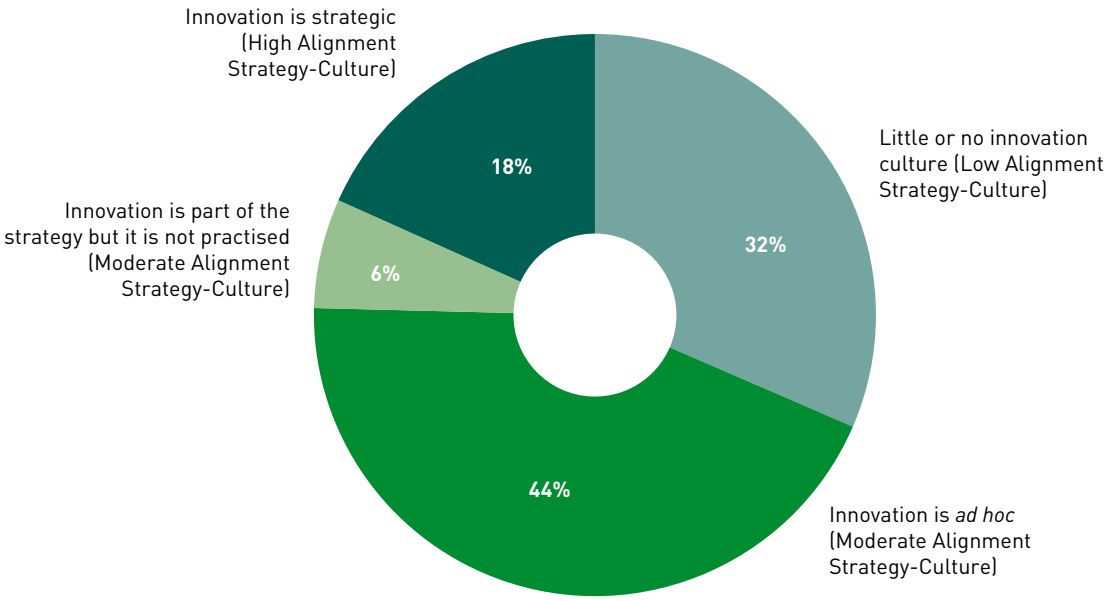
132 http://www.booz.com/global/home/what_we_do/services/innovation/innovation_thought_leadership/global_innovation_1000 [Accessed 20 September 2012].

133 Jaruzelski B, Loehr J & Holman R (2011) *Why Culture is Key, The Global Innovation 1000.* Booz & Co. Issue 65, Winter.

By adapting the Booz & Co. methodology to measure the level of innovative culture in Australian businesses, this report shows a representation of four main modes associated with innovation culture in Australia (Chart 4.2). The data shows that:

- Most Australian businesses (44%) have an innovation culture that is *ad hoc*. These businesses collaborate, are open to new ideas, consider their consumer needs when implementing innovation but only do this in a reactive way. The limitation in this approach to innovation is that it may depend on specific individuals or may fail to anticipate or learn from future challenges or opportunities, a key aspect of the most resilient entrepreneurs.[134]
- The second most common mode (at 32%) is of businesses that appear to lack an innovation culture or innovation strategy altogether. A larger proportion of Australian SMEs fit into this category. The Booz & Co. study found that a similar proportion (~27%) of the international businesses studied was in this category. Large businesses are much less likely to be part of this category (19%).
- A small percentage (6%) of Australian businesses had innovation as part of their strategy but undertook no innovation.
- A moderate percentage (18%) of Australian businesses have a high alignment between innovation strategy and innovation culture. Large businesses are much more likely to be part of this latter category (31%).

Chart 4.2: Innovation culture patterns in Australian businesses, 2008-09



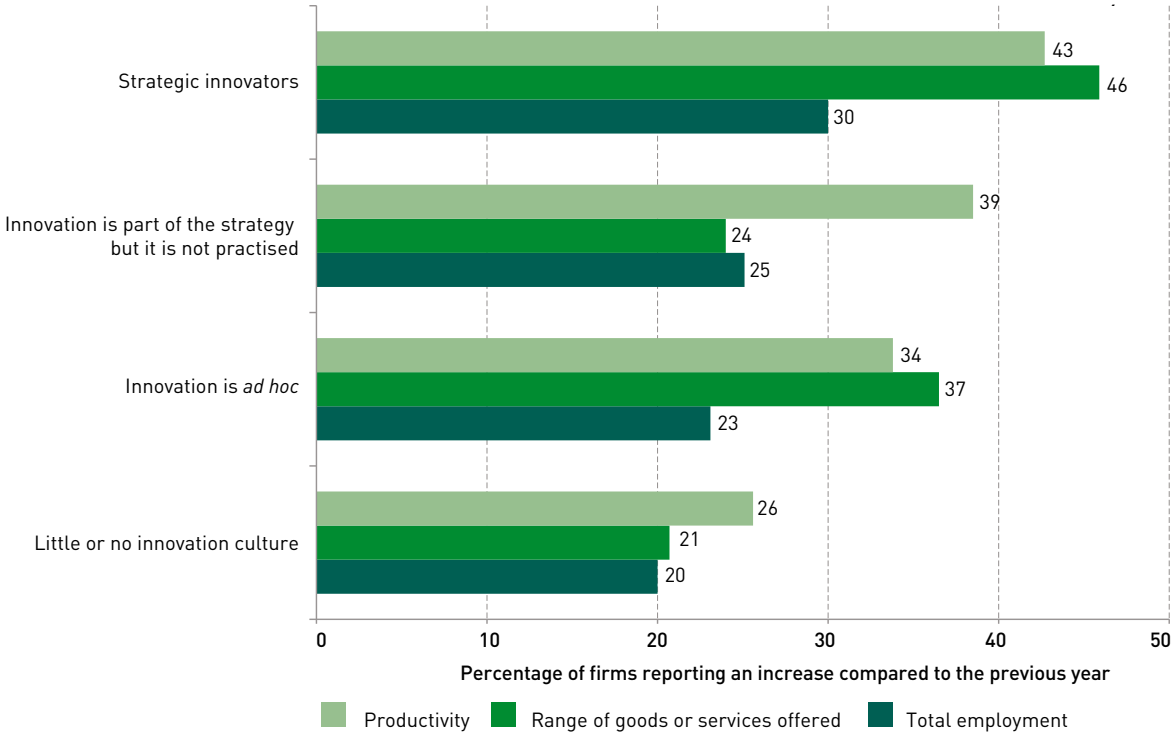
Source: ABS (2012) DIISRTE special data request, adapted from Booz & Co. report, *Why Culture is Key.*

134 Turner A (2012) *Blue Sky Mining: Building Australia's Next Billion Dollar Industries,* Amazon Digital Services.

As suggested in Chapters 1 and 2, being innovative pays off in terms of business performance. Businesses that have a high alignment between innovation culture and strategy not only outperform other businesses in increased productivity, but also in increases in the total employment and the range of new products and services offered (Chart 4.3).

There has been increasing concern about the quality of management in Australian businesses. A major international study of 9000 businesses (including Australia) collected data about business management. It found that management practices in Australia were mid-range among 20 countries and well below top performing countries such as the USA, Germany and Sweden,[135] indicating a considerable gap in management practices between multinational businesses operating in Australia and local family owned businesses.[136] With only 18% of Australian businesses being strategic innovators compared to 44% of the global leaders, Australia appears to be lagging in this aspect of business practice.

Chart 4.3: Innovation culture modes and impact on productivity, range of products offered and employment, 2008-09



Source: ABS (2012) DIISRTE special data request, adapted from Booz & Co. report, *Why culture is key.*

135 Dolman B & Gruen D (2012) *Productivity and structural change,* paper presented to the 41st Australian Conference of Economists, Melbourne, 10 July.

136 Green R (2009) *Management Matters in Australia: Just how productive are we?,* report commissioned by the Department of Innovation, Industry, Science and Research.

FEATURE: BUSINESS MODEL INNOVATION, DESIGN THINKING AND THE PRODUCTIVITY CHALLENGE

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What is a business model?

A business model defines the who, what and how of the business architecture:

- Who are the targeted customers?
- What is the value proposition offered to the target customers?
- How is the offering generated and provided and how does the business capture value?

The 'how' dimension covers a number of distinct components: the value chain or more often today the value network; the relationships with partners; the distribution channels; customer relationships; and the underlying revenue model. There are often many options in each of these dimensions. The feasibility and attractiveness of those options is continuously changing due to technological, market, regulatory and industry evolution, and to the strategies of suppliers, partners, customers and competitors. What is vital is focus and alignment - each element reinforcing the others and combining to form a well-integrated business model.

Business model innovation involves a realignment of the business and typically requires significant change in all or most of these dimensions. For example, Amazon began as 'just' a book retailer. But the real value proposition was the service – convenient, access to information to assess the book, reviews etc. The *who* was that growing market, the busy internet user who reads. The *how* was their excellent online platform and all of the relationships and logistics that support it.

Why is business model innovation increasing and important?

A range of studies over the past 10 years have identified business model innovation as a key factor in competitiveness. Business model innovation was a term heard often in the late 90s – along with the dot com start-ups. Its use declined with the end of the dot com hype. But just as the growth of web-based business is continuing and significant, so also is business model innovation. Not surprisingly the term re-emerged in the mid 2000s. A number of surveys, notably the 2006 IBM Global CEO Survey, began to show that high performing businesses were frequently those that had developed innovative business models. Since that time the number of business and academic books and papers on the topic has grown rapidly and more importantly there are many more examples of small and large businesses, and start-ups, in a diverse range of industries, that have designed and implemented new business models.

There are times when industrial and social change is deeper and more widespread. This is usually when new fundamental technologies disrupt established businesses, industries and patterns of trade. At such times viewing an economy as one based on equilibrating markets driven by equally informed and capable businesses is simply unrealistic and at its least relevant as a framework for policy. This is when it is not so much an issue of finding ways to produce more, more cheaply and with more features, but one of re-thinking those fundamental (business model) questions: what value, for whom, and how. Productivity may decline in order to later rise to new levels as new business models and capabilities are developed and applied. In periods like that we are experiencing now, the potential of new technologies and a new market is high but so is uncertainty. As the newspaper and retail industries demonstrate, the viability of old business models cannot be taken for granted. But it appears that they were.

To better see opportunities it is often essential to find a way to loosen our thinking so that we are free to explore different approaches to the key questions:

- Who are/ could be my customers?
- What is/ could be my value proposition?
- How do the products or services I offer, and the way in which I provide and support them, create value for my customers?
- How do the products or services I offer, and the way in which I provide and support them, create value for my customers?
- What aspects of value are most important to them – design, convenience, status, price etc?
- How do/ might I create and capture value?
- How will I produce the product or service?
- Will I work with other organisations for any elements of the value chain?
- What is the cost structure and how do I gain a return?

These questions become more important and more complex as markets are segmenting and new technology is enabling much greater customisation. The impact of increasing competition and global markets is often amplified by the internet, giving customers comparative pricing, product reviews and easier purchasing options.

A report by the Australian Business Foundation[137] provides examples of Australian businesses with innovative business models. These businesses have built knowledge and high skill intensive business models, with creativity and a smart use of technology, to achieve flexibility and a focused value proposition. They show the importance of a close alignment among the elements of the business model. They also show that business model innovation is likely to be a process with a stream of follow-on innovations that improve and extend the business model. Business models that have a tight alignment among elements and are embedded in unique processes, relationships and business cultures, are more likely to be effective and be difficult to copy. Business models involve a significant re-organisation of inputs such that significant productivity gains and other value can be realised without necessarily large capital expenditure or significant technological innovation.

As the level of collaboration is increasing in all aspects of commercial activity, from R&D and design to product support, the options for designing the how dimension of business models continue to widen.[138] Apple provides a powerful example here. For their iPad or iPhone, they have designed a product, a value chain and a value system. They supply none of the hardware components nor do they manufacture anything yet they capture the majority of the value add. Their products are platforms through which users create value, enabled but largely not created by Apple products.

The who, what and how components are the building blocks of a business model, and a significant change in one component often leads to change and re-alignment in the others and hence leads to a business model innovation. The components provide a framework for modelling how a business creates value and captures a share of that value. The framework can help to analyse, understand and assess the power and viability of your current business model. Constructing and exploring alternative models of a business helps to explore options for improvement and innovation. Business model innovation may include technological innovation, but just as often it involves organisational, service or product innovation enabled by new technology (see also Chart 3.3 of this report).

Many of the examples of very successful business models (Dell, Amazon, Zara) demonstrate how technological and organisational innovation is complementary. They show that it is often through business model innovation that the productivity improving potential of a new technology is realised and this requires different types of creativity and talent than for technological innovation.

Businesses are finding and profiting from different answers to the *who*, *what* and *how*. Amazon with (initially) online book retailing and Apple with the iPod, iPad and iPhone (and iTunes and the App Store) are well known examples of leaders with disruptive business models. The number of examples is now multiplying in Australia. J Robbins has responded to increasing competition from imports by moving out of high volume women's shoe production and building a new business model around a capability to have new designs in the store in days rather than months. This is a performance that high volume overseas

137 Scott-Kemmis D (2012) *Responding to change and pursuing growth: Exploring the potential of business model innovation in Australia,* Australian Business Foundation, January.

138 Findlay C et al. (2012) *Borders Blurred: The changing nature of trade in a globalised world,* Australian Business Foundation, February.

suppliers cannot match. The capability to produce that value proposition (timely, fashionable, high quality women's shoes) for the market niche (women seeking individual styles and contemporary fashion), i.e. the 'how', required a transformation of the equipment, the organisation, staff training and relationships.

Several businesses have adapted business models developed in other sectors or other countries. They identified the critical elements and then worked to design and implement a business model for their situation. This was the case with Jetstar. Inspired by the examples of Ryannair and SouthWest Airlines, Qantas studied these cases before embarking on building a low cost airline. They were particularly careful about re-using the systems and the culture of Qantas, recognising that a new organisation had to be grown from the start. Having identified an underserved niche (4 wheel drive tourists wanting robust trailers and caravans), Kimberly Kampers, redesigned the product and built a production system based on the low volume, high skill, flexible manufacturing approach.

Others have gradually evolved in response to opportunity and changing market demand. A good example is Orica Mining Services. Providing explosives to mining companies is a commodity business with low margins. But mining companies have been focusing increasingly on the front end (exploration and project approval) and back end (marketing and customer development) of the mining value chain, outsourcing most of the construction and production activities – their own business model innovation. In response Orica's business and its competence moved from selling chemicals to providing solutions, taking over a wider range of responsibilities in mining operations. Not only a new and higher margin business model, but a platform for developing a family of related mining services. Business model thinking is often vital for start-ups based on new technological innovations. They often only find success when it is recognised that a new business model is also needed. Some businesses seeking to sell new instruments have only become profitable after they changed the business model to instead sell services based on using the instruments. Consider the famous Xerox business model on which the business was built involved leasing expensive machines with a fee based also on usage.

A range of tools can be particularly valuable for assessing and designing business models. These are tools that can help:

- Identifying and exploring future options without being too heavily influenced by the past or preconceptions of the future;
- Mobilising the energy and creativity (and the critical analytical power) of groups to quickly bring different perspectives to the exploration;
- Engaging customers, potential customers, and other partners in an open ended exploration of value priorities and value propositions and hence creating opportunities for their input and creativity; and
- Conducting early experiments to test prototypes of possible products or services.

In addition to a range of specifically business model tools, the Design Thinking[139] approach brings a powerful range of tools and concepts. Businesses and production systems have become more inter-dependent, forming complex value systems, so that business model thinking is inevitably also systems thinking. Design Thinking approaches are being more widely used to shape the design of products, services, business and policies. Such tools are being used to identify options and to explore alternative futures. They are particularly useful today where capabilities and technologies are opening a much wider scope but where most business models (and the perspectives behind them) are conservative.

Website for further information:
www.abfoundation.com.au

139 Design Thinking refers to the methods and processes for investigating ill-defined problems, acquiring information, analyzing knowledge, and positing solutions in the design and planning fields. It is now being used as an innovation tool in business management.

Table 4.1: Indicators of Australia's innovation and entrepreneurship activity

Indicators	2006	2007	2008	2009	2010	2011	OECD average (latest year)	OECD top five average (latest year)	Gap from the top 5 OECD performers (latest year)	Ranking against OECD countries (latest year)	Change from baseline year to latest year (Baseline in bold)
Number of businesses registered for the R&D Tax Concession[1][r][a]	6,965	**7,906**	8,567	8,614	9,118	-	n/a	n/a	n/a	n/a	15.3%
BERD as % of GDP[2][r]	1.16	**1.27**	1.38	1.30	-	-	1.62	2.82	54%	12th	2.3%
Proportion of BERD financed by government[2][r]	3.9	**2.8**	2.2	2.1	-	-	8.9	15.3	86%	27th	-24%
Proportion of innovation-active businesses in Australia[3][r] [ea]	37.1	**44.9**	39.8	43.8	39.1	-	n/a	n/a	n/a	n/a	-13%
Proportion of innovation-active micro businesses (0-4 persons)[3][ea]	30.9	**37.0**	32.8	35.7	30.5	-	n/a	n/a	n/a	n/a	-18%
Proportion of innovation-active small businesses (5-19 persons)[3][ea]	44.6	**56.1**	48.4	54.7	49.6	-	n/a	n/a	n/a	n/a	-12%
Proportion of innovation-active medium businesses (20-199 persons)[3][ea]	56.3	**65.9**	58.2	61.2	61.9	-	n/a	n/a	n/a	n/a	-6.1%
Proportion of innovation-active large businesses (200 or more persons)[3][ea]	66.2	**70.8**	66.7	74.3	65.9	-	n/a	n/a	n/a	n/a	-6.9%
Proportion of businesses introducing goods innovation[4][ea]	10.4	**12.3**	9.7	10.6	9.6	-	n/a	n/a	n/a	n/a	-22%
Proportion of businesses introducing services innovation[4][ea]	11.3	**13.7**	12.3	13.2	11.4	-	n/a	n/a	n/a	n/a	-17%
Proportion of businesses introducing operational process innovation[3][ea]	17.0	**17.6**	16.3	16.9	16.4	-	n/a	n/a	n/a	n/a	-6.8%
Proportion of businesses introducing organisational/ managerial process innovation[3][ea]	16.5	**19.0**	19.4	20.7	18.9	-	n/a	n/a	n/a	n/a	-0.5%
Proportion of businesses introducing marketing innovation[3][ea]	12.9	**14.6**	17.2	16.7	16.8	-	n/a	n/a	n/a	n/a	15%
Business entry rate[5]	17.1	**15.3**	14.4	16.7	13.8	-	n/a	n/a	n/a	n/a	-9.3%
Business death rate[5][b]	14.6	**15.3**	15.4	13.1	13.5	-	n/a	n/a	n/a	n/a	-12%
Churn rate[5][c]	2.49	**-0.07**	-0.96	3.60	0.36	-	n/a	n/a	n/a	n/a	n/a
Business survival rates (annual)[5][d]	85.4	**84.7**	84.6	86.9	86.5	-	n/a	n/a	n/a	n/a	2.2%
Total early-stage entrepreneurship activity (TEA)[6][e]	**11.9**	-	-	-	7.8	10.5	8.2	14.5	No Gap	5th	-12%
Patents granted by IP Australia, for Australian residents[6]	924	**1,086**	925	926	1,178	1,266	n/a	n/a	n/a	n/a	17%
Designs certified by IP Australia, for Australian residents[6]	151	**238**	342	274	327	265	n/a	n/a	n/a	n/a	11%
Trade Mark applications from Australian residents[6]	40,538	**40,001**	38,381	38,466	39,633	43,112	n/a	n/a	n/a	n/a	7.8%

Indicators	2006	2007	2008	2009	2010	2011	OECD average (latest year)	OECD top five average (latest year)	Gap from the top 5 OECD performers (latest year)	Ranking against OECD countries (latest year)	Change from baseline year to latest year (Baseline in bold)
Innovation Patents by AU residents[5]	918	**1,034**	1,028	1,109	1,127	1,204	n/a	n/a	n/a	n/a	16%
Share of world triadic patent families (%)[2[r]]	0.65	**0.63**	0.65	0.61	0.58	-	2.8	15.9	96%	17th	-8.9%
Triadic patent families per million population[2[r]]	-	**15.0**	14.0	12.9	12.6	-	38.5	91.2	86%	19th	-16%
Share of world patent applications filed under PCT (%)[2[r]]	99	**95**	85	82	68	-	108	263	74%	20th	-28%
Patent applications filed by AU residents under PCT per million population[7]	96	**97**	90	79	79	77	n/a	n/a	n/a	n/a	-21%
Trademark registrations (AU resident) per million population[7]	1,120	1,221	**1,245**	1,123	1,077	1,119	n/a	n/a	n/a	n/a	-10%
Industrial design registrations (AU resident) per million population[7]	168	110	**113**	119	111	111	n/a	n/a	n/a	n/a	-2.2%

Sources:
1 Innovation Australia *Annual Report 2010-11*, DIISRTE unpublished data.
2 OECD *Main Science and Technology Indicators* database, 2012/1.
3 ABS (various) *Summary of IT Use and Innovation in Australian Business, 2006-07, 2007-08, 2008-09, 2009-10, 2010-11*, cat. no. 8166.0.
4 ABS (various) *Selected Characteristics of Australian Business 2006-07, 2007-08, 2008-09, 2009-10, 2010-11*, cat. no. 8167.0.
5 ABS (2012) *Counts of Australian businesses including entries and exits*, cat. no. 8165.0.
6 Global Entrepreneurship Monitor, *Adult Population Survey, 2011.*
7 Special Request IP Australia (IP Australia, WIPO and ABS)

Notes: Indicators with * and in the highlighted rows of the table are the primary indicators applied to measure and monitor progress against the Australian Government's innovation targets. (a) Registration data for the 2010-11 year (as at 30 June 2012) are incomplete; further applications for the 2010-11 income year will continue to be received up to 31 October 2012 from companies with non-standard income period balance dates. (b) The business death rate is defined as 100*(Exits/No. of businesses operating at the start of the financial year. (c) The churn rate is defined as Net (Births-Deaths)/Total Stock %, as it appears in the publication NESTA, Measuring Wider Framework Conditions for successful innovation: A system's review of UK and international; innovation data, January 2011, pp.36-37. (d) The survival rate is defined as 100 – Business death rate. (e) GEM defines Total Early-Stage Entrepreneurship Activity (TEA) as the prevalence rate of individuals in the working-age population who are actively involved in business start-ups, either in the phase preceding the birth of the business (nascent entrepreneurs), or the phase spanning 3 ½ years after the birth of the business (owner-managers of the new businesses). The cut-off point of 3 ½ years has been made on a combination of theoretical and operational grounds. [r] The data may have been revised according to the latest available data. [nd] No new data. [n/a] not available. [-] not applicable. [ea] ABS 8167.0 and 8166.0 data prior to 2009-10 excludes agriculture.

Business innovation performance

Table 4.1 describes Australia's performance in terms of a range of indicators on innovation over the last six years. The table reports on the proportion of businesses innovating and a number of proxy measures of innovation such as R&D expenditure and intellectual property protection. Expenditure on innovation by Australian businesses was estimated to be between $23 billion and $29 billion in 2010-11.[140] The investments most likely to be made by these businesses were in acquisition of machinery, equipment or technology (36%); training specific to innovation (27%) and marketing activities undertaken to introduce innovation (26%).[141]

OECD analysis[142] found that, for Australia, a 1% increase in business R&D expenditure would lead to a 0.11 percentage point increase in the long run rate of productivity growth. The number of businesses registering for the R&D Tax Concession has continued to increase (9.0%) to 9,118 in 2010 from 7,906 in 2007 (Table 4.1). Table 4.1 also shows the Business R&D expenditure (BERD) as a ratio of GDP. This data shows an increase of 12% between 2006-07 to 2009-10 to 1.30 percentage points. In 2009-10 Australia ranked 12th in the OECD on this indicator. More recent data (see Chart 4.7) shows a continuing increase.

140 ABS (2012) *Innovation in Australian Business, 2010-11, Appendix 2*, cat. no. 8158.0.
141 ABS (2012) *Innovation in Australian Business, 2010-11*, cat. no. 8158.0.
142 OECD (2006) *Sources of Knowledge and Productivity: How Robust is the Relationship?*, STI Working Paper 2006/6, Paris.

Despite growth in R&D the proportion of innovation active businesses has oscillated around 41% since 2006-07 (Table 4.1). As discussed in Chapter 1, R&D is performed by a limited number of businesses in Australia. Estimates of investment in intangible capital (see Chapter 1) show a general increase (5.3% compound annual growth rate) in intangible capital investment estimated since the mid 1970s (see Chapter 1). Despite this growing investment, innovation performance has remained relatively flat in recent years. Part of the explanation may come from the divergence between who is spending money on innovation and who is actually innovating in any given year: The majority of innovation-active businesses spent either nothing or less than $50,000 on innovation in 2010-11 (85%). Similar to what is happening to expenditure on R&D, medium-sized and large businesses are dominating investment in innovation to the extent that additional investment by these same businesses would net no additional increase in the proportion of businesses innovating. Putting it another way, businesses only have to innovate once to be considered innovation-active in any given year. It is a YES or NO answer in the ABS survey. So some businesses may be increasing investment in innovation but still only reporting a YES in any given year, despite the fact that they may be innovating multiple times with potentially greater impacts on productivity and other performance measures as seen in Chapter 1.

Unpacking the recent flat trend from 2006-07 onwards, generally technological product and process innovations have remained steady or declined, while generally non-technological managerial, organisational and marketing innovations appear to have increased over the same period (Table 4.1). Chart 4.4 shows international comparisons of proportions of large businesses and SMEs undertaking these different types of innovation. Differences in the types of innovation reflect differences in innovation strategies with Australia being similar to other OECD countries in its innovation strategy mix. The data shows that technological innovation and organisational or managerial innovation tend to occur together. The data is consistent with other research showing that organisational/business model innovation is a fundamental complementary investment for most technological innovations. Proportionally, in most countries, SMEs focus more on marketing and organisational innovations rather than product and process innovations. This may explain, with our high proportion of SMEs, why 37% of innovative Australian businesses spent no money on innovation in 2010-11 and an additional 48% spent less than $50,000.[143]

Countries' rankings in Chart 4.4 reflect innovation (all types) for large businesses, where Australia ranks towards the bottom of the OECD (26th out of 28 OECD countries). Comparisons based on total SME innovation show that Australia is in the middle range of the OECD at 16 out of 28 OECD countries. Not withstanding comparability issues in terms of impact of innovation or frequency of reporting, Australian SMEs seem to perform better on innovation relative to other countries than large Australian businesses. One possible explanation may be the relationship between the propensity to innovate and large business size distributions between countries. Innovation generally has a strong correlation with business size all around the world (see below) but our measure of large businesses is a rather open-ended 200 or more employees (for OECD comparisons this is 250+). If Australian large businesses are not as 'large' on average as their international counterparts, this may partly explain a poorer innovation performance. The reasons for this divergence merit further research.

Like all innovation systems, the Australian Innovation System is not a homogenous one. Every business, let alone every sector, has a unique history and complement of diverse motivations, resources, creativity and timing issues. The most innovation-active Australian sectors in 2010-11 were Wholesale Trade (58%), Retail Trade (49%), Professional, Scientific and Technical Services (47%) and Information Media and Telecommunications (48%). The industries with the lowest proportions of innovation activity were Transport, Postal and Warehousing (21%), Agriculture, Forestry and Fishing (30%) and Construction (27%).[144]

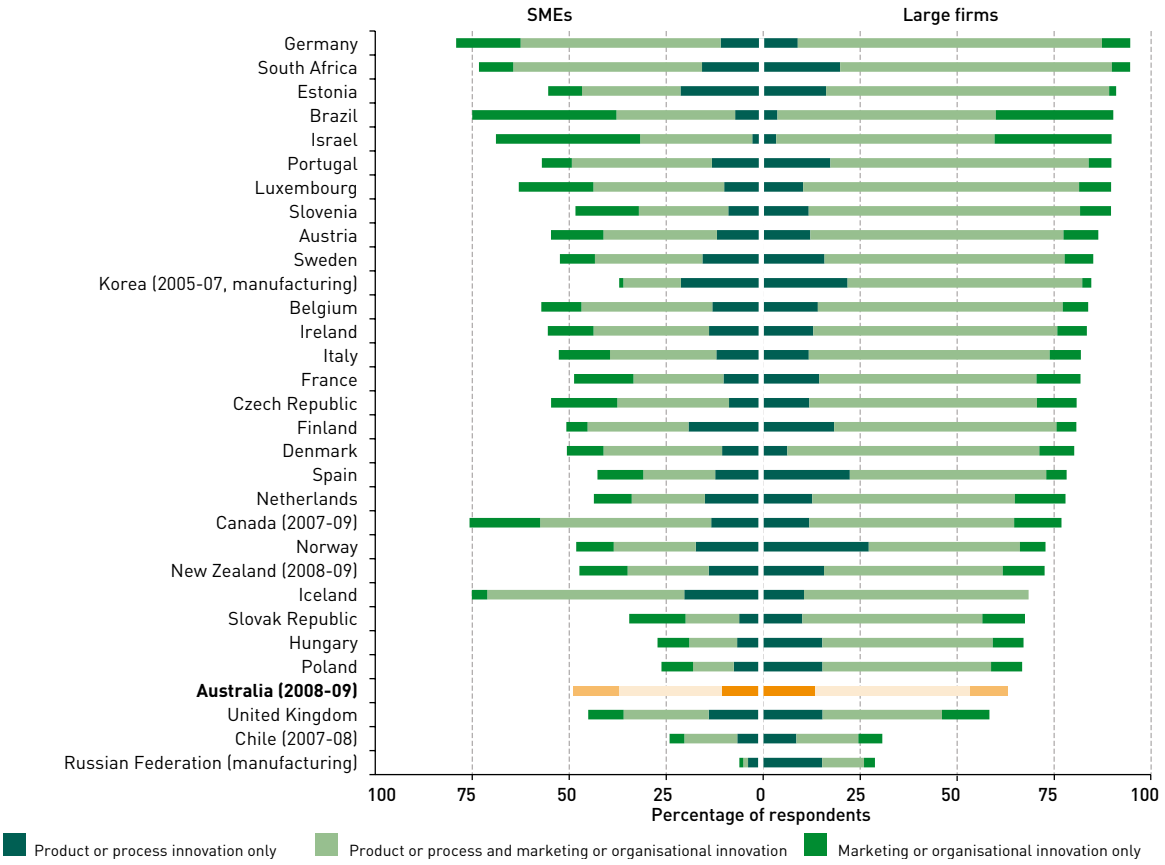
Chart 4.5 shows that R&D expenditure, a proxy measure of innovation investment represented as the size of the bubble, is generally well correlated with a sector's economic size. Chart 4.5 also serves to highlight the importance of technological intensity in the performance of different sectors and the role of industry structure and composition. Although the Education and Training sector has the largest expenditure on R&D, it allocates a considerable proportion of that R&D on the development of other sectors (see Chapter 2). Construction and retail trade are sectors that employ many low skill workers and are made up of a large number of small operators. Consider the difference between the corner store and the country wide supermarket chain or the sole-operator plumber versus the construction giant. Mining and Financial and Insurance Services are capital intensive sectors but also examples of where the big end of town is investing heavily in innovation.[145]

143 ABS (2012) *Innovation in Australian Business, 2010-11, Appendix 2,* cat. no. 8158.0.

144 ABS (2012) *Summary of IT Use and Innovation in Australian Business, 2010-11,* cat. no. 8166.0.

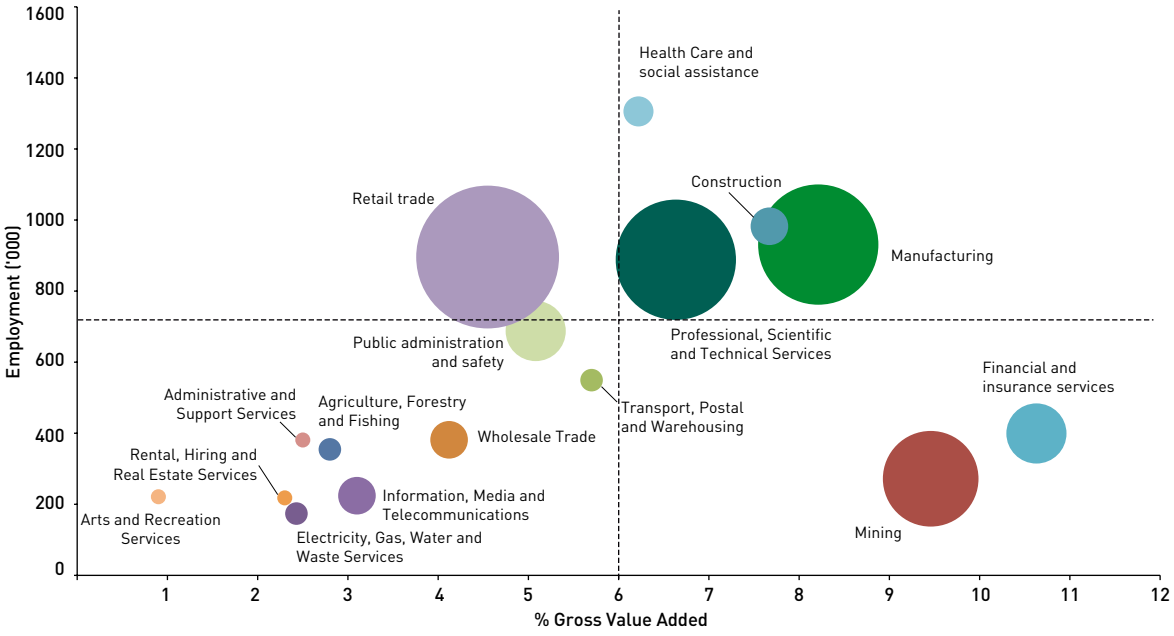
145 See *Australian Innovation System Report – 2011,* pp.58-60.

Chart 4.4: Innovation strategies by business size, 2006-08



Source: OECD (2011) *OECD Science, Technology and Industry Scoreboard 2011* and ABS (2012) special data request. Note that Australian data is split by OECD firm size classification. Ranking is by total innovation in large firms.

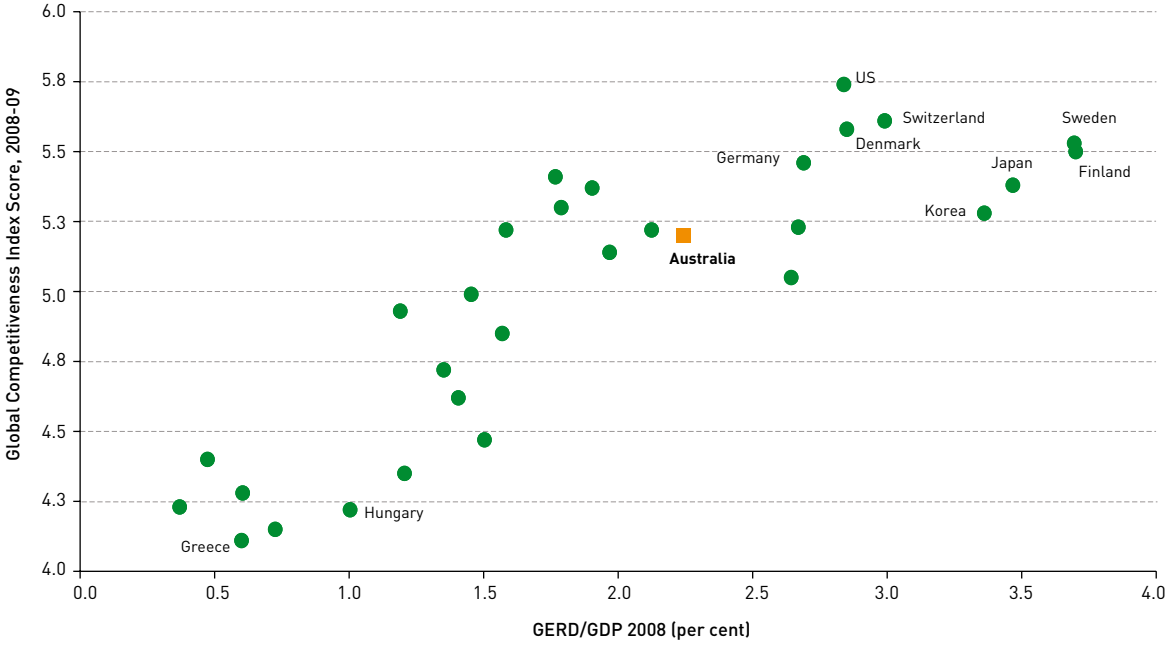
Chart 4.5: R&D expenditure by industry (size of bubble), size of employment and gross value added, 2010-11



Sources: ABS (2012) *Summary of IT Use and Innovation in Australian Business, 2010-11*, cat. no. 8166.0; ABS (2011) *Australian System of National Accounts, 2010-11*, cat. no. 5204.0; ABS (2012) *Australian Industry*, 2011-12, cat. no. 8155.0; ABS (2012) *Labour Force, Detailed, Quarterly, August 2012*, cat. no. 6291.0.55.003.

Expanding from a sectoral to country level averages out the structural variations and shows that, at a country level, investment in R&D is well correlated with global competitiveness (Chart 4.6). If Australia's investments in R&D continue to advance against other OECD countries, our competitiveness should increase in the long term. Latest estimates from the ABS show a fall in Australia's R&D intensity[146], however, country comparisons are unavailable so we do not know if our relative ranking has slipped on this indicator (see also Chapter 2).

Chart 4.6: Global competitiveness and R&D intensity (GERD/GDP), in OECD countries, 2008



Sources: The Global Competitiveness Index Scores were sourced from: World Economic Forum, *The Global Competitiveness Report 2011-12*, p. 16, Table 4. The GERD/GDP data was sourced from: OECD, *Main Science and Technology Indicators, 2012/1*.

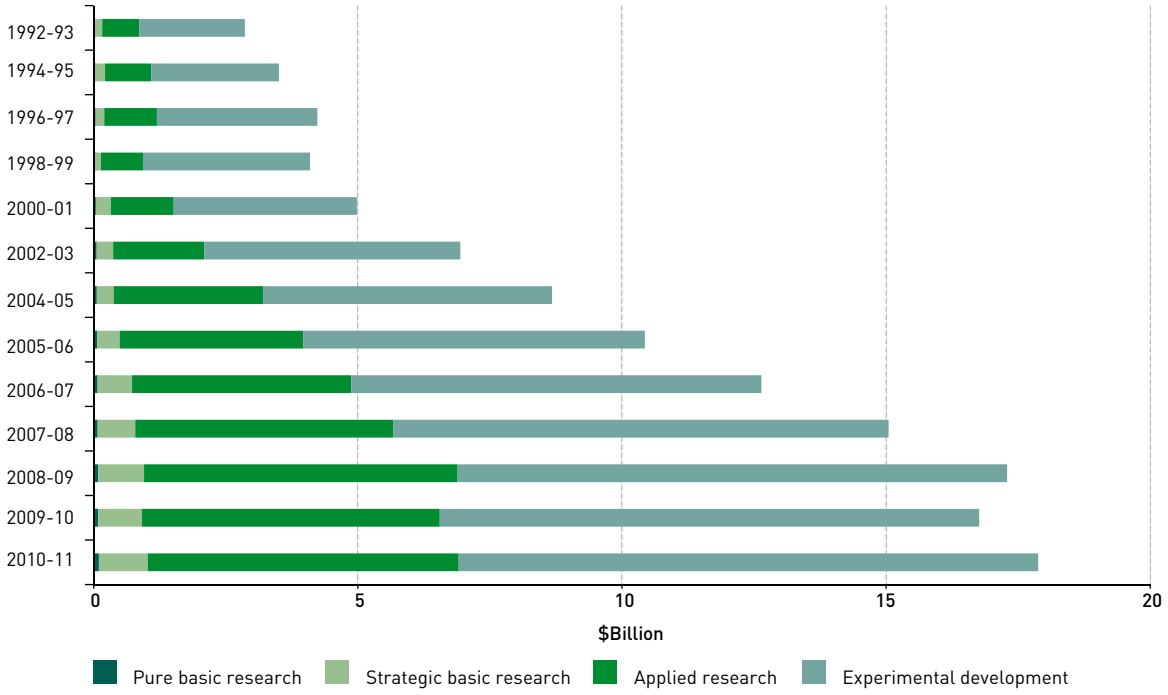
Note: The Global Competitiveness Index contains R&D expenditure as one of the inputs into the calculation of the index (indicator 12.03 - Company spending on R&D - in the 12th pillar (Innovation). The effect of this single indicator on the overall index score is however very small (around 2%). It is therefore unlikely that any trends between the index and GERD are a result of the R&D expenditure input into the competitiveness index.

Intellectual Property (IP) indicators such as patenting, design and trademark registrations are intermediate output indicators of innovation. Patenting and design have continued to grow despite a relatively stable rate of innovation more broadly (Table 4.1). Trademarking, noted by the OECD as a more broadly relevant indicator of innovation hitting markets is relatively stable, much like the proportion of businesses innovating (Table 4.1).

Underpinning the growth in design and patent applications is strong growth in business expenditure on R&D (BERD). R&D is an important innovation-related activity, with businesses accounting for 61% of total gross expenditure on R&D in 2008-09. Business expenditure on R&D has had a compound annual growth rate of 11% since 1992-93 with the highest growth rates in the early 2000s (Chart 4.7). As a result, BERD was $17.9 billion in 2010-11. Growth in BERD has been in all its forms: basic, strategic, applied research and experimental development, although experimental development and applied research are the fastest growing components (Chart 4.7; see also Chapter 2). Applied research is original work undertaken primarily to acquire new knowledge with a specific application in view. It is undertaken either to determine possible uses for basic research outcomes or to determine new ways of achieving some specific, predetermined objectives. The capacity for breakthrough innovations that create new products and markets and generate supernormal profit streams may therefore grow in the future, particularly in the Mining and Financial and Insurance Services sectors where growth is particularly strong.

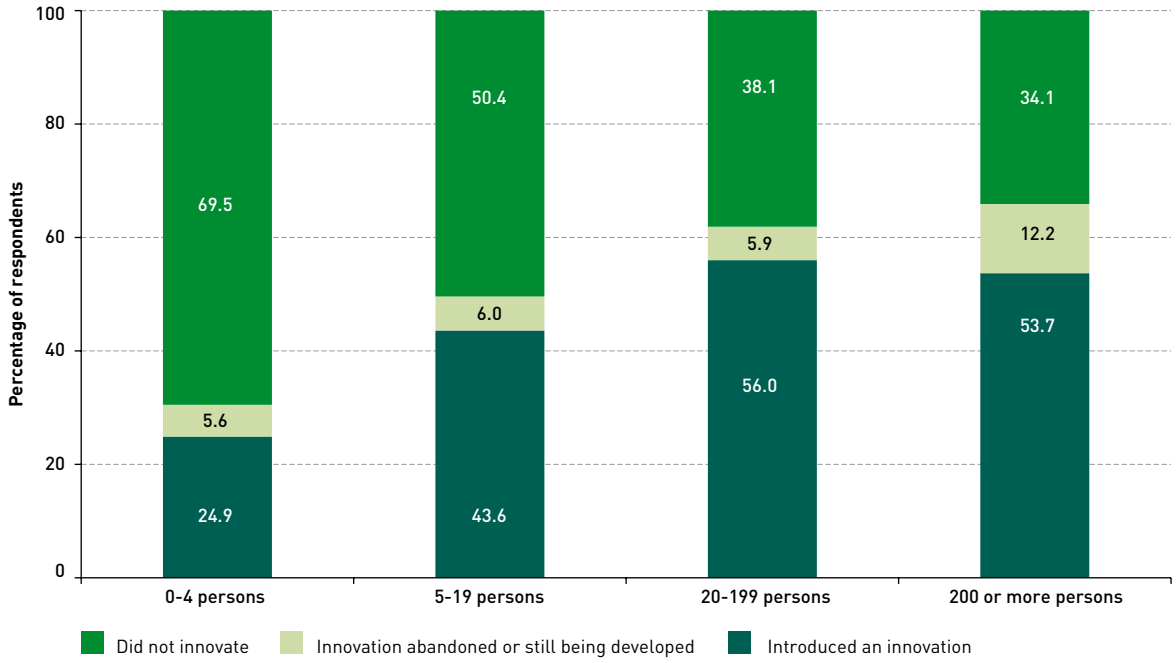
146 ABS (2012) *Research and Experimental Development, Businesses, Australia, 2010-11*, cat. no. 8104.0.

Chart 4.7: Business expenditure on research and development (BERD) by type of activity, 1992-93 to 2010-11



Source: ABS (2011) *Research and Experimental Development, Businesses, Australia, 2009-10*, cat. no. 8104.0.

Chart 4.8: Business innovation activity (%) by employment size, 2010-11



Source: ABS (2012) *Summary of IT Use and Innovation in Australian Business, 2010-11*, cat. no. 8166.0.
Note: The total 764,000 businesses represent the population of employing businesses for industries that are within the scope of the BCS. This figure differs from the estimated size of Australia's business population found in other collections such as the Australian Taxation Office's Australian Business Register. See ABS (2005) *A Statistical View of Counts of Businesses in Australia*, Information Paper, cat. no. 8165.0, for further explanation.

Innovation and business size

Like most OECD countries, Australia has a high proportion of SMEs in the business population.[147] SMEs represent approximately 99.7% of all Australian businesses.[148] In 2010-11, there were approximately 2.05 million active micro and small businesses (1.3 million of which are non-employing, predominantly self-employed) and 81,000 medium businesses. SMEs are economically significant for a number of reasons. Collectively they account for 58% of national output, 71% of national employment and are the birthplace of our future large and multinational businesses. The creation and destruction of small businesses is, to a large extent, the vehicle for market experimentation with new business models, new goods and new services. SMEs have low survival rates: of the 316,421 businesses that were created in 2007-08, only 71% survived the next year to June 2009, 57% the two years to 2009-10 and 49% survived to 2010-11.[149]

Due to a range of lower drivers and higher barriers (see above and also Chapter 1) SMEs are less likely to innovate than large businesses on average (Chart 4.8; medium-sized businesses are on equal footing with large businesses in the most recent official data set). Chart 4.8 shows that innovation activity by Australian businesses in 2009-10 increased with business size (as measured by its employment). Only 31% of micro businesses (of four or fewer employees) were innovation-active with this proportion increasing steadily with employment size, such that 66% of large businesses (200 or more employees) were innovation-active. However, the productivity dividend (and other benefits of innovation) is relatively greater for SMEs than for large businesses suggesting that innovation is more likely a make or break proposition for SMEs (Chart 4.9). Large businesses, while as equally driven to innovate for profit as SMEs (Chart 4.1), are not seeing those benefits (Chart 4.9). Given that large businesses are more likely to innovate from year to year, perhaps the impacts of innovation persist longer for large businesses. Other clear differences in performance such as greater efficiencies, market differentiation, exporting (Chart 4.9) and perhaps reducing environmental impacts may also be the main outcome.

Business framework conditions

As discussed in previous chapters, analysis of the environment in which innovation happens (so called framework conditions) is important for understanding the *why* and *how* of innovation. Previous sections of this report have dealt with some framework conditions such as skills development, research capacity and culture.

Framework conditions such as competition, openness of the economy to trade and investment and market price signals can facilitate innovation.[150] For example, 75% of innovation-active businesses were motivated by framework conditions such as competition, demand and market related drivers.[151] It has been argued that the recent business environment has weakened incentives to innovate.[152] Although framework conditions appear to be generally positive, there is little quantitative information that describes how well markets are functioning to encourage innovation. Factors such as efficient pricing in markets can have a significant impact on incentives for market experimentation.[153] Competitive pricing is currently a moderate driver of innovation (Chart 4.1; Table 4.2). However, the extent to which the market is effective in encouraging innovation is not currently measured. Analyses of framework conditions are also complex as sometimes they can be both drivers and barriers to innovation depending on circumstance and perspective.[154] Chart 4.10 suggests that, according to businesses, standards are a net driver of innovation across all business sizes, whereas government regulation is a net barrier to innovation, particularly for smaller businesses. This is not to suggest that governments only act as barriers to innovation (see Chapter 1; Chart 1.6). For example, governments are often the institutions that create, maintain or enforce standards.

147 See DIISRTE (2011) *Australian small business: Key statistics,* Canberra.

148 Structural and Demographic Business Statistics (SDBS), OECD – figures cited in DIISR (2009) *Submission to the Productivity Commission inquiry into Raising the Level of Productivity Growth in the Australian Economy*.

149 ABS (2012) *Counts of Australian businesses, including entries and exits*, cat. no. 8165.0

150 Productivity Commission (2009) *Submission to the House of Representatives Standing Committee on Economics: Inquiry into Raising the Level of Productivity Growth in Australia,* September.

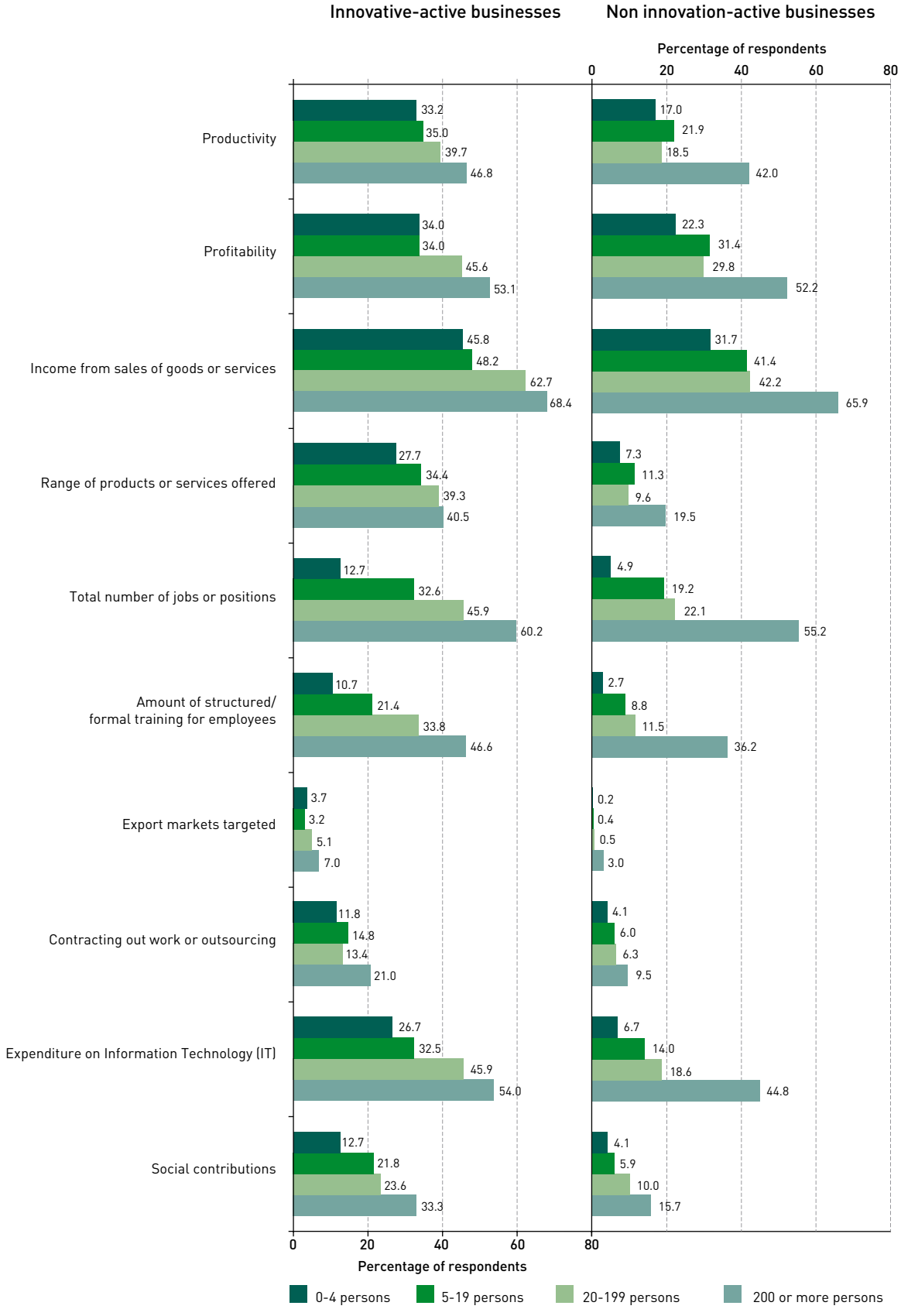
151 ABS (2012) *Innovation in Australian Business, 2010-11*, cat. no. 8158.0.

152 D'Arcy P & Gustafsson L (2012) *Australia's productivity performance and real incomes, Reserve Bank of Australia Bulletin,* June quarter.

153 Productivity Commission (2009), *op. cit*.

154 Allman K et al (2011) *Measuring wider framework conditions for successful innovation: A system's review of UK and international innovation data,* Nesta, UK.

Chart 4.9: Increases in business performance and activities compared to previous year, by innovation status, by employment size, 2010-11



Source: ABS (2012) *Selected Characteristics of Australian Business, 2010-11*, cat. no. 8167.0.

Table 4.2 shows a range of framework condition indicators. Australia's international rankings remain moderate to high although a number of indicators have fallen in value in recent years, particularly around the financing of innovation. Barriers to entrepreneurship are low and the cost of starting a business has fallen since 2006. World Economic Forum data[155] gauges the extent to which pay provides incentives to be productive. Australia is ranked 12th out of 34 OECD countries on incentives to be productive, being equal to the OECD average. Analysis suggests this indicator is tightly coupled with management quality (data not shown).

Table 4.2: Business framework conditions and other incentives to innovate

Indicators	2006	2007	2008	2009	2010	2011	2012	OECD average (latest year)	OECD top five average (latest year)	Gap from the top 5 OECD performers (latest year)	Ranking against OECD countries (latest year)	Change from baseline year to latest year (Baseline in bold)
Buyer sophistication[1[a][y]]	5.3	**4.8**	4.7	4.4	4.2	4.1	-	4.1	5.1	19%	20th	-14.6%
Business level technology absorption[1[b][y]]	5.7	**5.8**	5.9	5.9	5.8	5.9	-	5.5	6.2	5%	11th	1.7%
Percentage of final household consumption expenditure on Health, Communications and Education[2[r]]	12.0	**11.9**	12.3	12.4	12.4			8.9	17.8	30%	6th	4.1%
Government procurement of advanced technology products[1[c][y]]	4.2	**4.1**	4.0	4.1	3.9	3.7	-	3.8	4.5	18%	23rd	-9.8%
Tax treatment of R&D (1 - B Index)[3[f]]	-	-	**0.12**	-	-	0.35	-	0.11	0.34	No Gap	2nd	199%
Intensity of local competition[1[y]]	5.7	**5.7**	5.7	5.7	5.9	5.9		5.4	6.0	No Gap	5th	3.5%
Trade (% GDP)[4[r]]	41	**41**	41	45	40	41	-	107	200	79%	26th	1.8%
Business impact of rules on foreign direct investment (FDI)[1[y]]	5.3	**5.3**	5.1	4.9	4.9	5.0	-	4.8	5.7	13%	15th	-5.7%
Net Foreign Direct Investment Inflows as a percentage of GDP[4[r]]	3.52	**4.79**	4.45	2.95	2.70	-	-	1.91	87.7	100%	11th	-44%
Total investment in early stage venture capital as a % of GDP[5]	0.136	**0.077**	0.055	0.032	0.018	-	-	n/a	n/a	n/a	n/a	-77%
Early stage venture capital investment ($m)[6]	136	**249**	208	147	102	-	-	n/a	n/a	n/a	n/a	-59%
Annual Venture Capital Investment ($m)[6]	813	**901**	683	420	252							-72%
Annual Later Stage Private Equity investment ($m)[6]	1,328	**1,868**	994	824	825	-	-	n/a	n/a	n/a	n/a	-56%
Proportion of businesses seeking debt or equity finance for innovation (% of respondents)[7[ea]]	13.6	**15.4**	12.7	11.1	8.2	-	-	n/a	n/a	n/a	n/a	-47%

155 World Economic Forum, *The Global Competitiveness Report 2012-2013.*

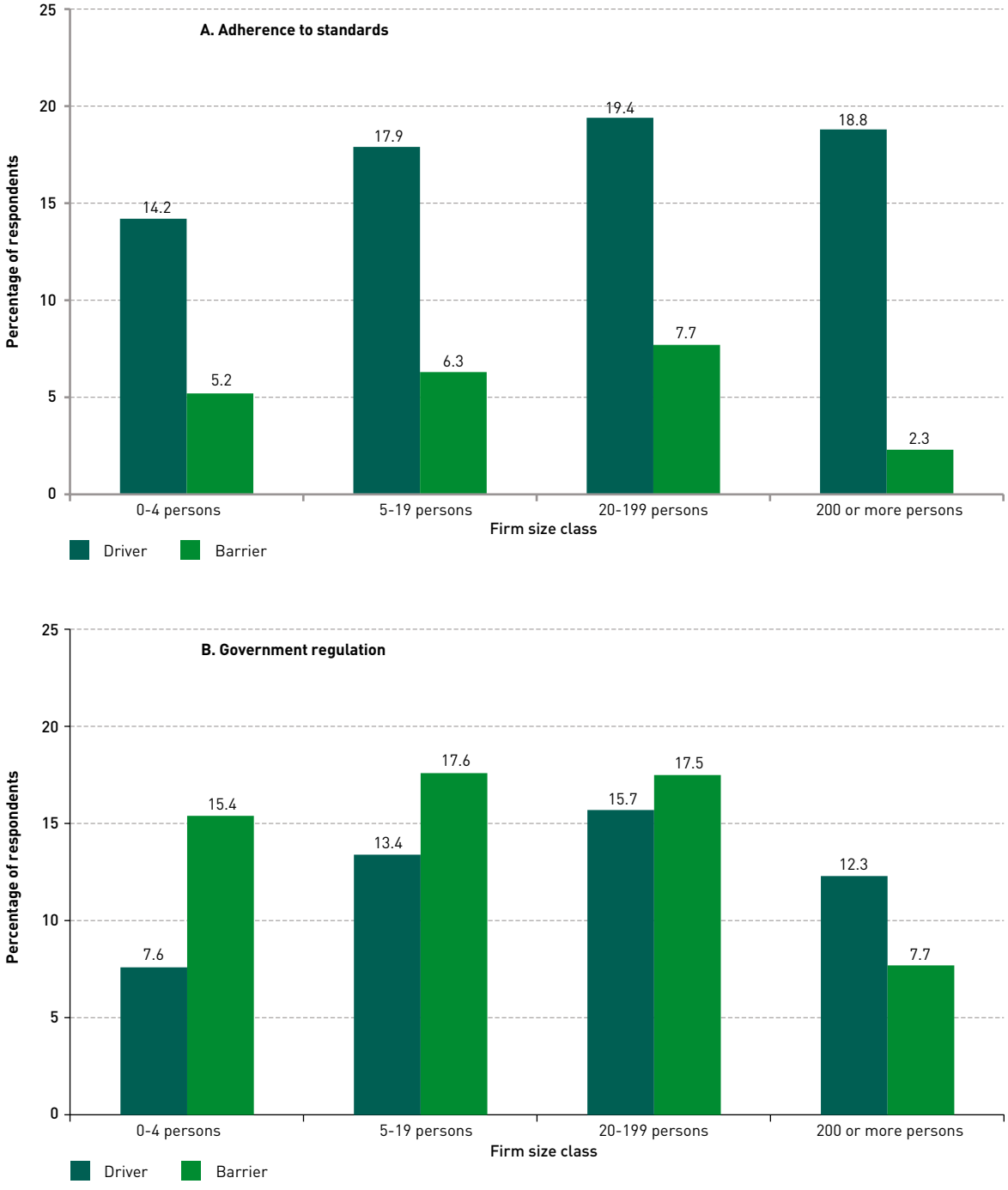
Indicators	2006	2007	2008	2009	2010	2011	2012	OECD average (latest year)	OECD top five average (latest year)	Gap from the top 5 OECD performers (latest year)	Ranking against OECD countries (latest year)	Change from baseline year to latest year (Baseline in bold)
Market capitalization of listed companies (% of GDP)[4][r]	146	**151**	64	136	129	87	-	72	117	25%	8th	-42%
Stocks traded, total value (current US$billion)[4][r]	826	**1,323**	1,018	762	1,222	1,246	-	1,524	8,335	85%	9th	-5.8%
Stocks traded, total value (% of GDP)[4][r]	110	**154**	96	82	108	91	-	113	150	39%	7th	-41%
Stocks traded, turnover ratio (%)[4][r]	87	**110**	103	79	90	94	-	143	184	49%	11th	-15%
Barriers to innovation - Any barrier (%of respondents)[7][ea]	46.3	**43.7**	43.2	44.6	44.9	-	-	n/a	n/a	n/a	n/a	2.7%
- Lack of access to additional funds (% of respondents)[6][ea]	15.9	**16.0**	19.5	18.4	21.1	-	-	n/a	n/a	n/a	n/a	32%
- Government regulations or compliance (% of respondents)[7][ea]	10.3	**10.6**	11.9	14.5	13.0	-	-	n/a	n/a	n/a	n/a	23%
Entrepreneurial intentions[8]	-	-	-	-	**8.70**	12.30	-	12.86	26.04	53%	9th	41%
Barriers to entrepreneurship[9]	-	-	**1.14**	-	-	-	-	1.39	0.97	18%	7th	n/a
Statutory corporate income tax rates (%)[10]	30	**30**	30	30	30	30	30	25	18	170%	27th	No change
Start-up procedures to register a business (number)[4]	2	**2**	2	2	2	2	-	5	2	No Gap	3rd	No change
Cost of business start-up procedures (% of GNI per capita)[4]	1.8	**0.8**	0.8	0.8	0.7	0.7	-	5.1	0.2	191.7%	7th	-13%

Sources:

1 World Economic Forum, *The Global Competitiveness Report 2007-08, 2008-09, 2009-10, 2010-11, 2011-12*, and *2012-13.*
2 *OECD Factbook Statistics* (OECD.Stat).
3 OECD (2009) *OECD Science, Technology and Industry Scoreboard 2009*, OECD, Paris. Data for Australia has been adapted by the Kauffman Foundation for the *Global Innovation Policy Index* (2012).
4 World Bank (2012) *World Development Indicators & global development finance.*
5 ABS (2012) *Venture Capital and Later Stage Private Equity, Australia, 2010-11*, cat. no. 5678.0; ABS (2011) *Australian System of National Accounts, 2010-11*, cat. no. 5204.0.
6 ABS (2012) *Venture Capital and Later Stage Private Equity, Australia, 2010-11*, cat. no. 5678.0.
7 ABS (various) *Business Characteristics Survey 2006-07, 2007-08, 2008-09, 2009-10, 2010-11* cat. no. 8167.0.
8 *Global Entrepreneurship Monitor: Adult Population Survey, 2010 & 2011.*
9 OECD (2010) *Measuring Innovation: A New Perspective,* Paris.
10 KPMG (2012) *Corporate tax rates by country table*, KPMG Global Website. www.kpmg.com [Accessed: 2 August, 2012].

Notes: Indicators with * and in the highlighted rows of the table are the primary indicators applied to measure and monitor progress against the Australian Government's innovation targets. (a) For this indicator, survey respondents were asked to answer the question "In your country, how do buyers make purchasing decisions? [1=based solely on the lowest price; 7=based on a sophisticated analysis of performance attributes] (b) For this indicator, survey respondents were asked to answer the question "To what extent do businesses in your country absorb new technology? [1=not at all; 7=aggressively absorb]" (c) For this indicator, survey respondents were asked to answer the question "Do government procurement decisions foster technological innovation in your country? [1=no, not at all; 7=yes, extremely effectively]" (d) For this indicator, survey respondents were asked to answer the question "How would you assess the intensity of competition in the local markets in your country? [1=limited in most industries; 7=intense in most industries]". (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) The B index is defined as the present value of before tax income necessary to cover the initial cost of R&D investment and to pay corporate income tax, so that it is profitable to perform research activities. The amount of tax subsidy for R&D is calculated as 1 minus the B index. Therefore, the higher the 1-B-index is, the greater the tax subsidy. (g) OECD rankings are performed on those OECD countries for which data is available. Individual data availability may vary between indicators. Rankings from previous reports have been revised and may vary as a result. [r] The data may have been revised according to the latest available data. [nd] No new data. [n/a] not available. [-] not applicable. [y] Data is as at earliest year in publication date i.e. 2011 data is from the year 2011-2012 WEF Publication. [ea] ABS cat. no. 8167.0 and 8166.0 excludes agriculture.

Chart 4.10: Adherence to standards (panel A) and government regulation (panel B) as a driver of or barrier to innovation reported by innovation-active Australian businesses, by size, 2010-11



Source: ABS (2012) *Innovation in Australian Business*, 2010-11, cat. no. 8158.0.

New data from the Kauffman Foundation's report indicates that Australia's tax treatment of R&D (1-B Index 0.350) ranks 2nd among the OECD and well above OECD average of 0.107 in terms of generosity.[156] Trends in consumers' ability to understand and use innovation, businesses' ability to absorb new technology and household and government purchasing of technology intensive products are mixed. Regardless of trend, other countries have become more sophisticated such that Australia's OECD ranking has dropped substantially out of the top ten. Australia's household consumption of more advanced goods and services (health, communication and education) has increased marginally over the last five years to 12.4% (ranked 6th).

Chapter 1 (Chart 1.6) shows that lack of access to additional funds are a significant and growing barrier to innovation. More broadly the percentage of Australian businesses seeking finance for innovation has also declined by 40% over the same period (Table 4.2). Australia has a private equity industry comprising venture capital and later stage private equity. Venture capital refers to the high risk end of private equity and is a mechanism to support the growth of new, innovative companies (pre-seed, seed, start-up and early expansion), while later stage private equity finances activities such as late expansion, company buyouts and turnarounds. Since 2007-08, venture capital and later stage private equity investment in Australia have been on the decline (Table 4.2). This trend is not restricted to Australia, but is evident in other global private equity markets.[157]

Case studies

Emerging world first metal process technology with global implications for the transport industry

The development of a pilot machine of a new manufacturing process developed in Victoria could deliver the first steps toward significant benefits for global transport markets worth more than $100 billion.

Victorian Centre for Advanced Materials Manufacturing (VCAMM) has led development of a pilot-scale version of the Continuous Equal Channel Angular Processing (CECAP) technology developed by Monash University. The development of the pilot scale system has benefitted from support by the Victorian Government through its innovation and technology programs, and significant financial and technical support from a global aerospace partner.

CECAP mechanically refines the grain structure of metals, improving the strength, formability, and joinability in sheet metals, with or without expensive alloying additions or specialised thermal processing, depending on the target application. It promises to deliver high-performance, lightweight materials that are critical to the efficiency of future of transport industry products through CECAP's potential to be the world's first process capable of delivering mass-produced 'ultra-fine grain' alloys.

Global aerospace, automotive and aluminium suppliers have already expressed interest in the progress of the process from its successful demonstration in the laboratory to this new scale. The demands to reduce product weight and costs in all transport sectors is reaching a critical point as environmental legislation, fuel costs, and resource scarcity drive up the complexity and materials requirements of vehicle structures. Applicable to alloys of steel, aluminium, titanium and magnesium in sheet and plate form, CECAP will appeal to industries looking to manufacture targeted lightweight, high-performance materials and components.

Validation activities on the pilot machine are underway to demonstrate the scalability and benefits of the technology to target markets, with further development programs being discussed with strategic industry partners along target supply chains.

CECAP could enter world markets within five years and could create significant new industry options for Australia resulting in wide-ranging financial and employment opportunities. While this Australian solution to low cost, high strength and lightweight materials could provide ongoing commercial and research opportunities to its stakeholders, there is another aspect of considerable appeal. Australia's mature aluminium and steel sheet industries could readily adopt this technology and directly provide

156 It is important to indicate that due to limitations of the B-index measure, features such as refunding and carry-forward or carry-back mechanisms are not included in this analysis; nor are the taxpayer and asset bases to which the R&D tax incentive is applied.

157 OECD (2012) *Financing SMEs and Entrepreneurs*, Paris.

new alloy solutions globally. Furthermore, with mature and highly capable manufacturing industries, the benefits of CECAP materials could provide the broader Australian manufacturing community new globally competitive bases providing assembly-ready major component systems into major supply chains or products.

VCAMM welcomes contact from parties interested in CECAP's technical and commercial opportunities.

Website for further information:
www.vcamm.com.au

The world's first comprehensive greenhouse gas analyser

Researchers from the University of Wollongong have partnered with Australian environmental monitoring company, Ecotech, to manufacture and distribute the world's first comprehensive greenhouse gas analyser to worldwide markets.

The Spectronus, developed by researchers at the School of Chemistry in the University of Wollongong (UOW) in 2000, gives a high precision, real-time analysis of all principal greenhouse gases, capabilities unmatched by its competitors. It is already in use within Australian government organisations, including the Queensland Department of Agriculture, Fisheries and Forestry, Victoria's Department of Sustainability and Environment and the Australian Nuclear Science & Technology Organisation (ANSTO). Internationally, it is currently used by government organisations and universities in Germany, France, Finland, China, South Korea and New Zealand.

To meet growing demand, Ecotech will manufacture the analyser in Australia and distribute it via its worldwide network under a licensing agreement with the University of Wollongong.

The partnership comes at a critical time in Australia since the carbon price arrangements came into effect on 1 July 2012. Worldwide, there is an increasing need for governments to accurately measure greenhouse gases in their environments.

"Policy decisions based on climate change research demand precise, highly accurate and repeatable data for all greenhouse gases, not just CO_2," said Professor David Griffith, Head of the UOW Research Team.

Other gases such as methane, nitrous oxide, carbon monoxide, along with water vapour, are all important in any comprehensive assessment of atmospheric effects on and by climate change. The Spectronus analyser offers, for the first time, a single high-accuracy instrument which simultaneously measures important greenhouse gases.

Spectronus greenhouse gas analyser

"One of the major benefits of the analyser is its long-term performance stability without the need for frequent calibration," said Nicholas Dal Sasso, Ecotech's Managing Director.

The Spectronus hardware is complemented by powerful operating software which results in a flexible, fully-automated system that can be controlled remotely.

"This partnership is a great example of the tertiary education and manufacturing sectors working together on an Australian innovation which will reach global markets," said Nicholas Dal Sasso.

Draggin goes full throttle and wins international design award

Fiona and Grant Mackintosh receive their CE (Conform to Europe) certificate

Draggin, the Australian family-owned small business has spent five years developing their C-Evo jeans, which are able to withstand abrasion normally experienced during a motorbike fall. Draggin's patented knitted lining provides superior protection against heat and abrasion from the road surface, providing the highest level of protection available.

In July 2011 Draggin was awarded a prestigious international Red Dot award, Europe's premier design award. Draggin Jeans has this year been recognised for supreme quality and high level of performance and safety by being awarded an International Arch of Europe Award at the 38th International Quality Convention, in Germany.

"It took five years of this rigorous in-house development and testing to gain Conform to Europe (CE) approval and Draggin are the only jeans to gain this international standard," Fiona said. "For the motorcycle industry the CE test results are the real deal. The CE tests prove if a product performs in a motorcycle accident. Draggin will keep judging its products only according to the CE standard."

In 2011 international sales grew, and with new distribution deals in the UK, Europe and the US, this trend is set to continue.

"Our jeans have Dyneema in the lining, which is the world's strongest fibre," Fiona said. "It is 40% stronger than Kevlar and 15 times stronger than steel. Although safety is our number one priority, we provide fashionable designs for men and women of all ages."

Fashion and comfort is also a high priority. Draggin jeans look like normal jeans and are designed with the latest fashions in mind.

While safety development required the majority of investment, the company did recognise the need to also invest in fashion development and research to help ensure commercial success.

"We are producing the best motorcycle jeans in the world – which is a great achievement for a small Australian business. We are the world's most protective jeans, and we intend to continue development work to maintain our position."

Before establishing Draggin, Grant ran an apparel manufacturing company which made jeans for international brands such as Levis, Wrangler, Lee, Country Road and Quicksilver.

Soon after establishing the Draggin range in 1997 Grant personally tested the strength of the Kevlar lining by being dragged on the road by a motorcycle at 110km an hour. The experience cemented his desire to continue to research and develop high quality protective materials to protect motorcycle riders. Rather than using cheaper alternatives, Draggin has defined itself by only using the highest quality materials.

CHAPTER 5

Links and collaboration

There are a number of reasons for the importance of collaboration. The intensification of global competition has drastically shortened product lifecycles and this has meant businesses have to develop new products and services more efficiently. Innovation has become more complex and costly, requiring ever more diverse knowledge inputs. Increased specialisation has reduced the diversity of knowledge available within businesses, requiring them to look outside their boundaries for expertise.[158] This trend to specialisation and division of labour has occurred in the research sector as well, leading to high quality research now being dominated by collaborative work (see Chapter 2, Chart 2.1). In summary, businesses, research institutions, government agencies, regulators, community organisations and others are increasingly seeing collaboration as the way to maintain or increase the quality of outcomes in productivity, profit, market share or other objectives.

Chapter 5 discusses the role of collaboration in innovation and productivity, describes Australia's collaboration performance compared with that of other countries and showcases a number of case studies of collaboration on innovation. Developments in government policies and programs to encourage collaboration on research and innovation are included in the Compendium of program updates accompanying this report at www.innovation.gov.au/AISreport2012/program_compendium. More detail on the compendium can be found in Appendix 1.

Collaborative innovators have the edge

As discussed in the introduction to this report, innovation systems theory recognises the importance of collaboration for innovation efficiency.[159,160,161] Organisations 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; and, in the case of businesses expand their market reach and achieve economies of scale.[162] Of course organisations collaborate on projects other than innovation.[163] Looking at all businesses, not just those that innovate, compared to businesses that don't collaborate, collaborative Australian businesses are 55% more likely to report increased productivity (other businesses performance measures are also positively affected).[164]

This appears at first glance to be quite a significant benefit. Innovation and collaboration in the 21st century increasingly go hand in hand.[165] Nearly nine in ten executives surveyed for the GE Global Innovation Barometer believe innovation is about partnerships, not individual success.[166] Australian data supports this belief with innovation-active businesses more than three times more likely to collaborate than non-innovation active businesses.[167] Chart 5.1 unpacks the relationship between collaboration and innovation and shows that collaboration without innovation does not appear to confer a significant or immediate productivity advantage. This is also the case for other performance measures, except for benefits to the number of export markets targeted, expenditure on IT and social contributions such as charity contributions.

158 OECD (2010) *The OECD Innovation Strategy: Getting a Head Start on Tomorrow,* OECD, Paris.

159 *Ibid*.

160 OECD (2009) *Innovation in Firms: A Microeconomic Perspective,* OECD, Paris.

161 Cosh A, Fu X & Hughes A (2005) *Management characteristics, collaboration and innovative efficiency: Evidence from UK survey data,* University of Cambridge Centre for Business Research Working Paper 311.

162 MacCormack A, Forbath T, Brooks P & Kalaher P (2007) Innovation through global collaboration: A new source of competitive advantage, *Harvard Business School Working Paper 07-079;* Australian Industry Group (2010) *Innovation: New Thinking New Directions, report by the Innovation Review Steering Group,* Sydney; Ternmouth P, Herrmann K & Docherty D (2010) *Absorbing Research: The role of university research in business and market innovation,* CIHE, London; D'Este P & Perkmann M (2010) Why do academics engage with Industry? The entrepreneurial university and individual motivations, *The Journal of Technology Transfer*. 36: 316-339; Cosh A, Fu X & Hughes A (2005) Management characteristics, collaboration and innovative efficiency: Evidence from UK survey data, *University of Cambridge Centre for Business Research,* Working Paper 311; Spoehr J et al (2010) *Connecting Ideas: Collaborative Innovation for a Complex World,* Australian Institute for Social Research, Department of Further Education, Employment, Science and Technology, South Australia, May.

163 Collaboration can include joint marketing and distribution, joint R&D, joint buying, joint production and supply chain integration.

164 ABS (2011) Data analysis commissioned by DIISRTE, 2009-10, cat. no. 8167.0.

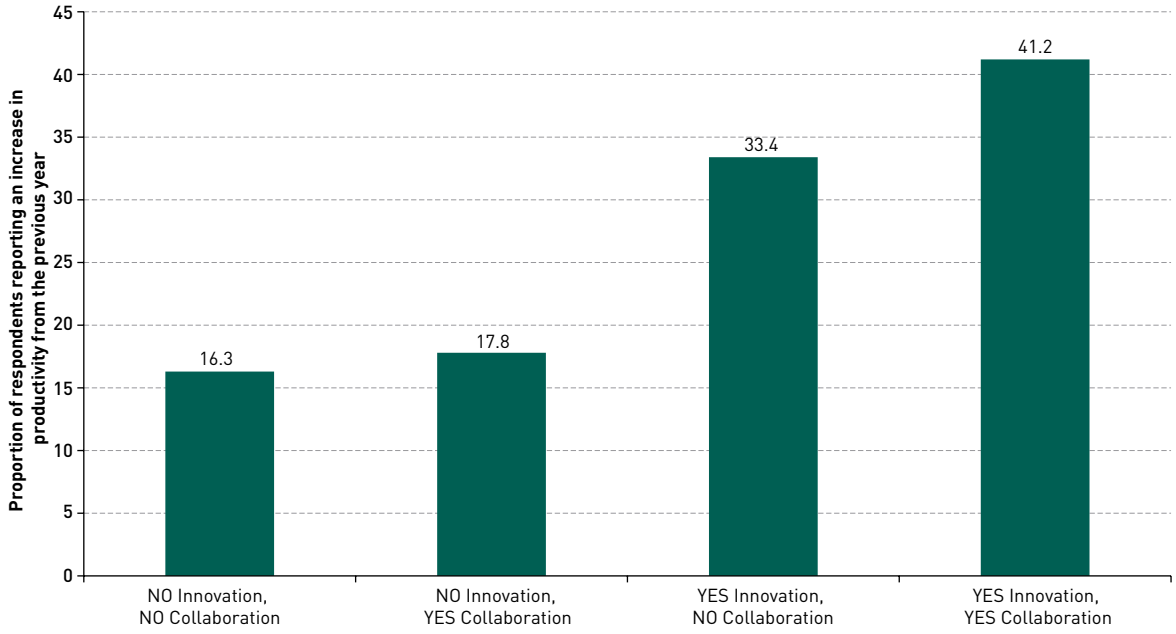
165 Gray C (2006) Absorptive capacity, knowledge management and innovation in entrepreneurial small firms. *International Journal of Entrepreneurial Behaviour and Research* 12: 345-360; OECD (2010) *The OECD Innovation Strategy: Getting a Head Start on Tomorrow,* Paris.

166 GE *Global Innovation Barometer 2012* http://www.ge.com/innovationbarometer/key_findings.html (Accessed 13 June 2012.

167 ABS (2011) *Selected Characteristics of Australian Business, 2009-10*, cat. no. 8167.0.

However, Chart 5.1 also shows that there are compounding productivity benefits accruing to businesses that pursue a culture of both innovation and collaboration. This is the case for most of the business performance measures.

Chart 5.1: Productivity performance by innovation status and by collaboration status, 2009-10



Source: ABS (2012) *Innovation in Australian Business, 2009-10*, cat. no. 8167.0, customised output. Collaboration activity is for any purpose.

Collaboration also considerably enhances the capacity of innovation-active businesses to offer a wider range of products and services to the market, while significantly driving up their expenditure on information technology (Chart 5.2). Compared to innovative businesses that don't collaborate, innovative Australian businesses that collaborate are:

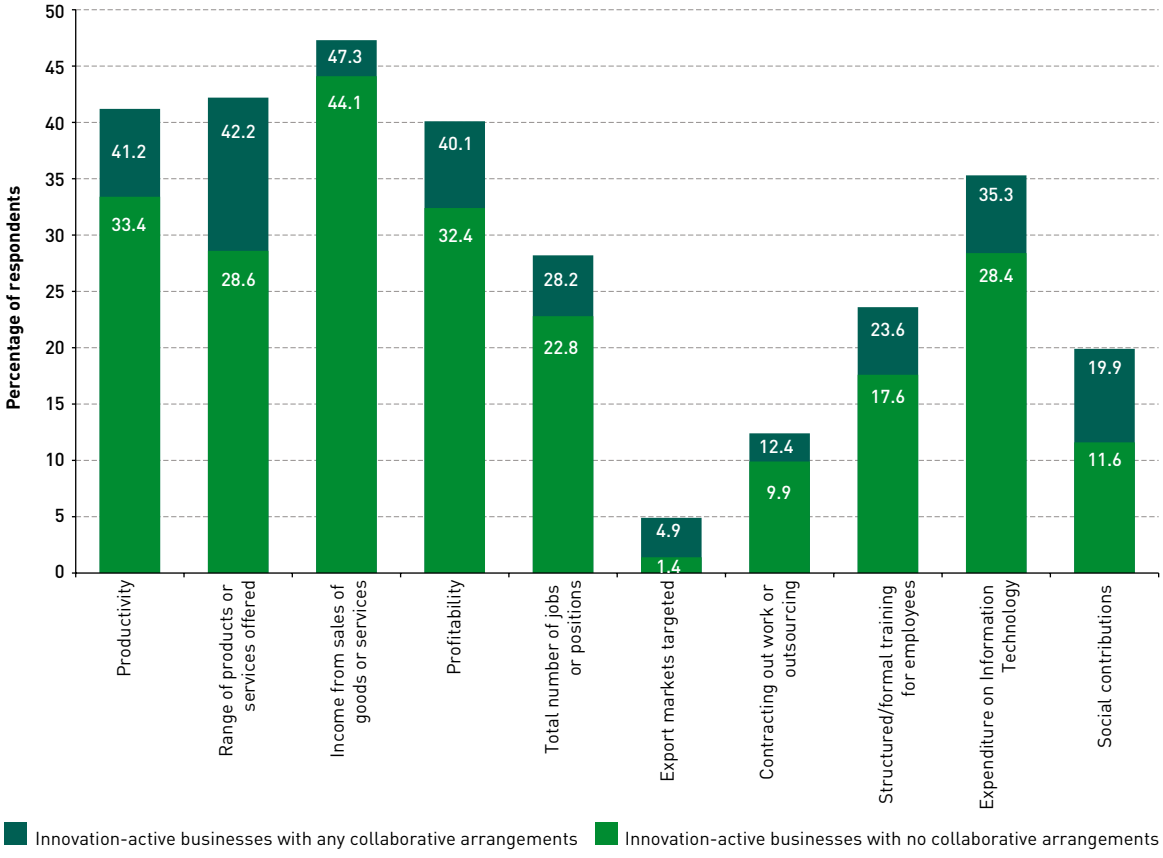
- 23% more likely to report increased productivity;
- 24% more likely to report increased profitability;
- More than three times more likely to increase the number of export markets targeted;
- 48% more likely to increase the range of goods or services offered;
- 24% more likely to increase employment; and
- 34% more likely to increase training for employees. [168]

Innovation-active Australian businesses that collaborate are also more likely to introduce world-first innovation than those that do not collaborate (see also Chart 3.2).[169]

168 ABS (2011) Data analysis commissioned by DIISRTE.

169 DITR (2006) *Collaboration and Other Factors Influencing Innovation Novelty in Australian Businesses: An Econometric Analysis*, Department of Industry, Tourism and Resources, Canberra.

Chart 5.2: Increases in business performance and activities of innovation-active businesses compared to previous year, by collaboration status, 2009-10



Source: ABS (2012) Data analysis commissioned by DIISRTE from the *Business Characteristics Survey*, 2009-10.

Collaboration performance

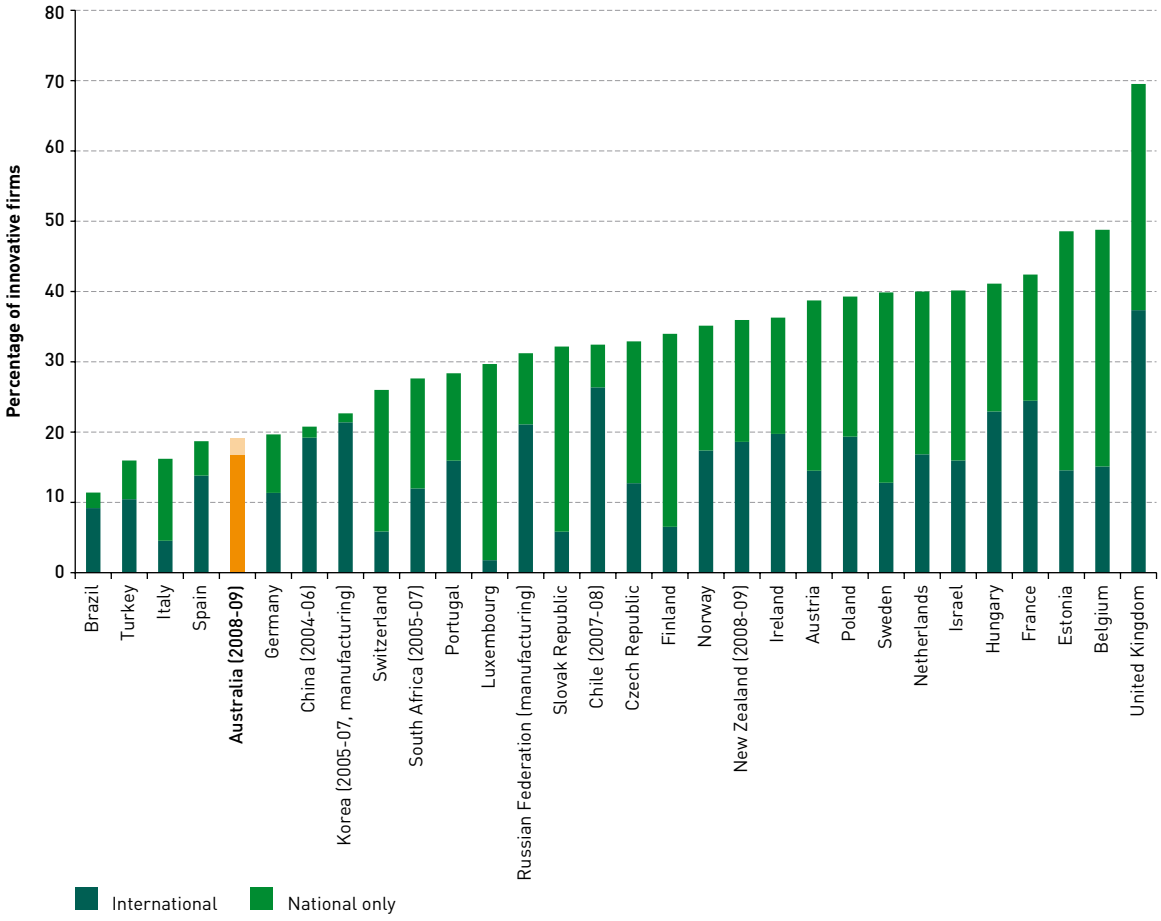
Despite the benefits of collaboration for innovation described above, Australian innovative businesses do not seem to be collaborating as much as they should. Australia is ranked 23rd out of 26 OECD countries in terms of proportion of businesses collaborating on innovation, an indication that Australian businesses are poor collaborators by OECD standards (Chart 5.3). Global Competitiveness Report indicators of the extent of networking such as the 'state of cluster development' and 'value chain breadth' show that Australia is considerably behind other OECD countries, ranking 21st and 34th, respectively, among the 34 OECD countries.[170]

The proportion of businesses that collaborate on innovation has increased from 21% in 2006-07 to 25% in 2010-11 (Table 5.1). This increase has occurred across all size-classes, but is relatively greater for micro, small and medium sized businesses.[171] The extent of collaboration varies considerably between sectors with averages in 2010-11 varying between 12% and 34%. It is worth pointing out that when we talk about collaboration on innovation we are mostly talking about business-to-business or user-driven collaboration. Official data shows that in 2010-11, 18-39% of Australian businesses collaborating on innovation did so with other businesses in the same group or with the market (suppliers, customers, competitors, etc.) compared to 2-6% with institutional sources (research, government etc).

170 World Economic Forum, *The Global Competitiveness Report 2012-2013*.

171 ABS (2012) *Innovation in Australian Business, 2010-11*, cat. no. 8158.0.

Chart 5.3: National and international collaboration on innovation by firms, 2006-08



Sources: OCED 2011 *OECD Science, Technology and Industry Scoreboard 2011*, based on Eurostat (CIS-2008) and national data sources, June 2011; ABS (2012) DIISRTE special data request from *Innovation in Australian Business, 2008-09*, cat. no. 8158.0.

In the great majority of OECD countries, large businesses are significantly more likely to collaborate on innovation than small businesses. However, in the case of Australia, the gap between collaboration by large and small businesses is narrower or non-existent. Recent official data indicates that 24.4% of large Australian businesses collaborated for the purpose of innovation in 2010-11 compared to 22.6%, 24.4% and 24.8% for micro-, small- and medium-sized businesses, respectively. Relative to other OECD countries Australia was ranked very poorly on collaboration for innovation (Chart 5.4) and large businesses in Australia were ranked last in the OECD (28th out of 28 countries). Australian SMEs have slipped considerably in their international ranking down to 27th out of 28 OECD countries. Even with the high volatility in the frequency of collaboration and the differences in the reference periods between Australia and other OECD countries, this data is a poor result.

Table 5.1: Australia's performance in knowledge exchange against other OECD countries

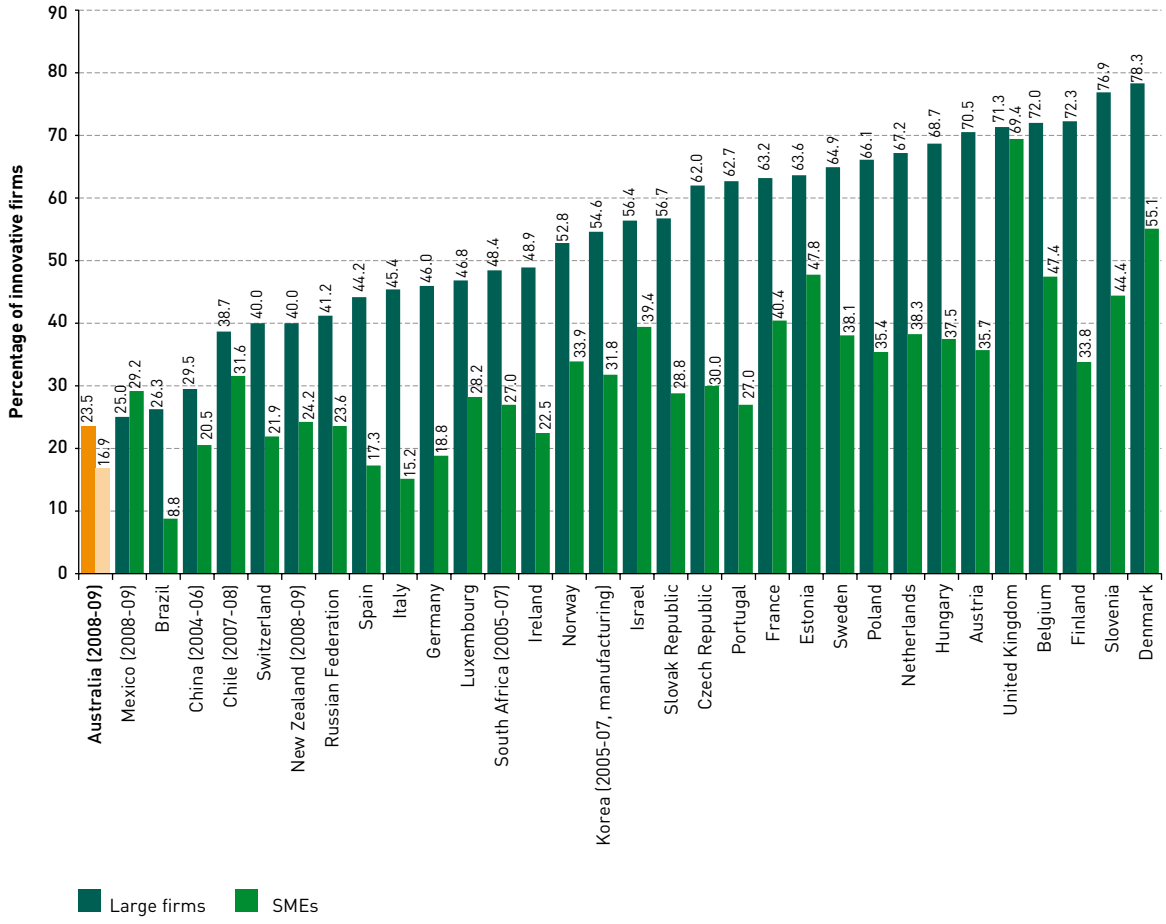
Indicators	2006	2007	2008	2009	2010	2011	OECD average (latest year)	OECD top five average (latest year)	Gap from the top 5 OECD performers (latest year	Ranking against OECD countries (latest year)	Change from baseline year to latest year (Baseline in bold)
Proportion of innovation-active businesses collaborating for any reason (% of respondents)[1[ea]]	**15.9**	20.7	22.5	22.2	22.4	-	n/a	n/a	n/a	n/a	41%
Proportion of non-innovation active businesses collaborating for any reason (% of respondents)[1[ea]]	**6.4**	6.5	7.6	6.7	7.4	-	n/a	n/a	n/a	n/a	16%
Proportion of innovation active businesses collaborating with universities or other research institutions excluding commercial (%)[*2]	**12.1**	-	9.5	-	9.6		n/a	n/a	n/a	n/a	-21%
Proportion of innovation active SME businesses collaborating with universities or other research institutions excluding commercial (%)[2]	**12.1**	-	9.5	-	9.6		n/a	n/a	n/a	n/a	-21%
Proportion of innovation active large businesses collaborating with universities or other research institutions excluding commercial (%)[2]	**12.7**	-	15.8	-	13.7		n/a	n/a	n/a	n/a	8%
Proportion of Australian businesses collaborating on innovation (%)[*3]	**20.6**	-	17.1	-	25.0	-	n/a	n/a	n/a	n/a	21%
Proportion of SMEs collaborating on innovation (%)[4[y]]	**17.7**	-	16.9		24.9	-	n/a	n/a	n/a	n/a	41%
Proportion of large businesses collaborating on innovation (%)[4[y]]	**23.5**	-	23.5	-	24.4	-	n/a	n/a	n/a	n/a	17%
Gross income from Licenses, Options and Assignments by publicly funded research agencies and universities ($million)[5]	116.5	**226.3**	91.3	296.7	-	-	n/a	n/a	n/a	n/a	31%
Gross income from contracted research and consultancies by publicly funded research agencies and universities ($billion)[5]	1.2	**1.3**	1.2	1.2	-	-	n/a	n/a	n/a	n/a	-11%
Number of start-up companies in which publicly funded research agencies and universities have an equity holding[5]	172	**178**	173	176	-	-	n/a	n/a	n/a	n/a	-1.1%
Proportion of HERD financed by business (%)[6[r]]	**6.76**	-	5.86	-	-	-	6.45	14.60	60%	14th	-13%
Proportion of GOVERD financed by business (%)[6[r]]	**11.5**	-	9.9	-	-	-	3.6	13.5	26%	7th	-14%
Share of world's top 1% highly cited publications attributed to domestic collaboration, Social Science and Humanities (%)[7]	0.46	**0.62**	0.69	0.96	1.16	1.37	1.02	5.37	No Gap	4th	122%

Indicators	2006	2007	2008	2009	2010	2011	OECD average (latest year)	OECD top five average (latest year)	Gap from the top 5 OECD performers (latest year	Ranking against OECD countries (latest year)	Change from baseline year to latest year (Baseline in bold)
Share of world's top 1% highly cited publications attributed to domestic collaboration, Natural Sciences and Engineering (%)[7]	1.32	**1.43**	1.69	1.90	2.15	2.46	2.06	9.49	74%	7th	72%

Sources:
1 ABS (various) *Selected Characteristics of Australian Business, 2006-07, 2007-08, 2008-09, 2009-10, 2010-11* cat. no. 8167.0.
2 ABS (2012) Special DIISRTE data request.
3 OECD (2010) *Measuring Innovation: A New Perspective*; ABS (2012) special DIISRTE data request, from *Innovation in Australian Business, 2008-09 and 2010-11*, cat. no. 8158.0.
4 OECD (2009) *OECD Science, Technology and Industry Scoreboard 2009;* ABS (2012) special DIISRTE data request from *Innovation in Australian Business, 2008-09 and 2010-11*, cat. no. 8158.0.
5 DIISR (2011) *National Survey of Research Commercialisation 2008-2009.*
6 OECD *Main Science and Technology Indicators* database, 2012/1.
7 InCites™, Thomson Reuters (2011), DIISRTE special request.

Notes: Indicators with * and in the highlighted rows of the table are the primary indicators applied to measure and monitor progress against the Australian Government's innovation targets. (a) OECD rankings are performed on those OECD countries for which data is available. Individual data availability may vary between indicators. Rankings from previous reports have been revised and may vary as a result. [r] The data may have been revised according to the latest available data. [nd] No new data. [n/a] not available. [-] not applicable. [y] Years span two year ranges i.e. 2006=2004-2006. [ea] ABS 8167.0 data prior to 2009-10 excludes agriculture.

Chart 5.4: Firms collaborating on innovation activities by business size, 2006-08

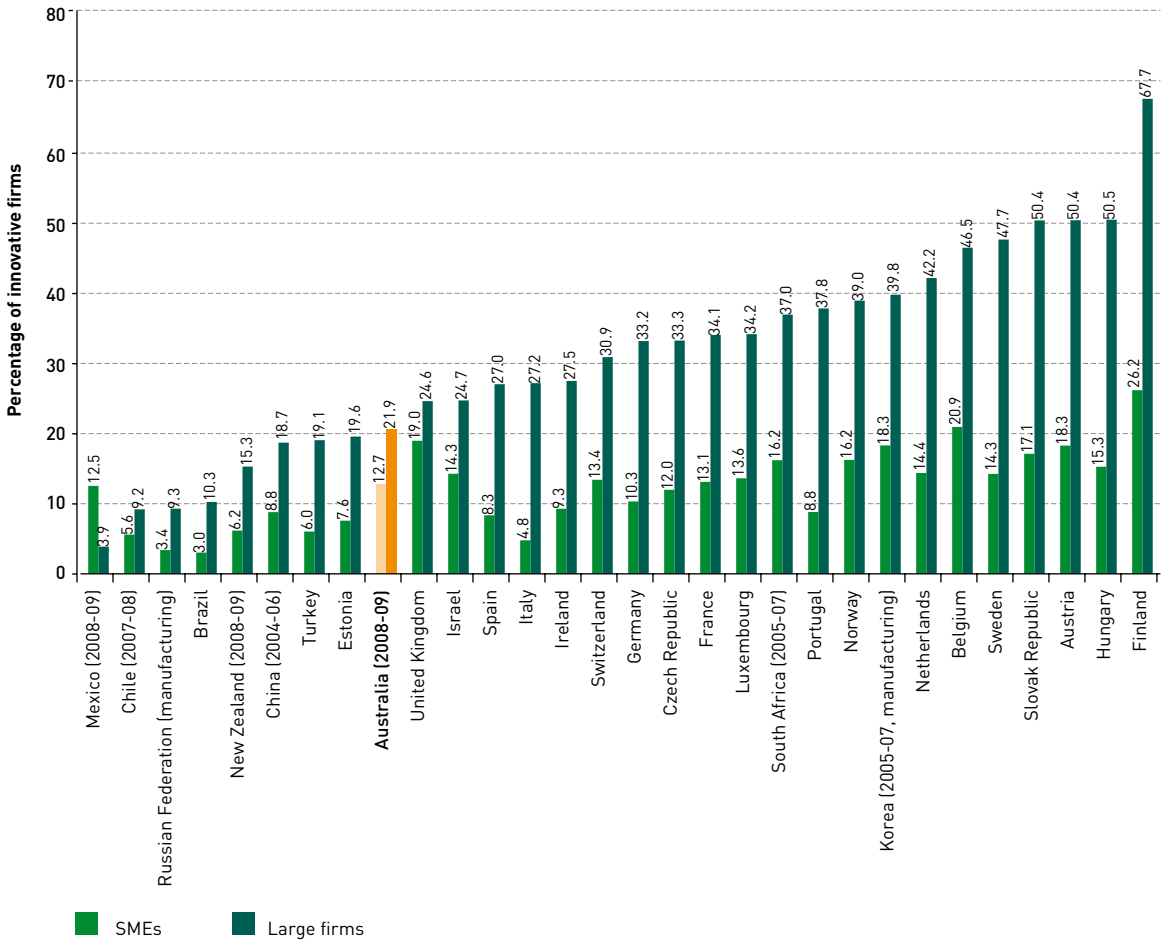


Sources: *OECD Science, Technology and Industry Scoreboard 2011*, based on Eurostat (CIS-2008) and national data sources, June 2011; ABS (2012) DIISRTE special data request from *Innovation in Australian Business, 2008-09*, cat. no. 8158.0.

Research collaboration

Australia is above OECD-average for total number of researchers (per thousand employed in the population), but a low proportion of business researchers. There is therefore potentially significant scope for industry to benefit from the research expertise that Australia has in its government agencies and universities through linkage and collaboration. OECD data also shows that universities and the public research sector, in general, are sought out far less frequently by businesses, as sources of ideas for innovation.[172] ABS data indicates that Australian businesses follow a similar trend for collaboration between businesses and research organisations on innovation (Chart 5.5). Large businesses rank 21st at 21.9% and SMEs rank 15th at 12.7% out of 26 OECD countries on this indicator.

Chart 5.5: Businesses collaborating on innovation with higher education or government research institutions by business size, 2006-08



Sources: OECD 2011 *OECD Science, Technology and Industry Scoreboard 2011*, based on Eurostat (CIS-2008) and national data sources; ABS (2012) DIISRTE special data request from *Innovation in Australian Business*, 2008-09, cat. no. 8158.0.

172 OECD (2011) *OECD Science, Technology and Industry Scoreboard 2011*, Sources of knowledge for innovation, by type, 2006-08, p.102 (based on Eurostat (CIS-2008) and national data sources).

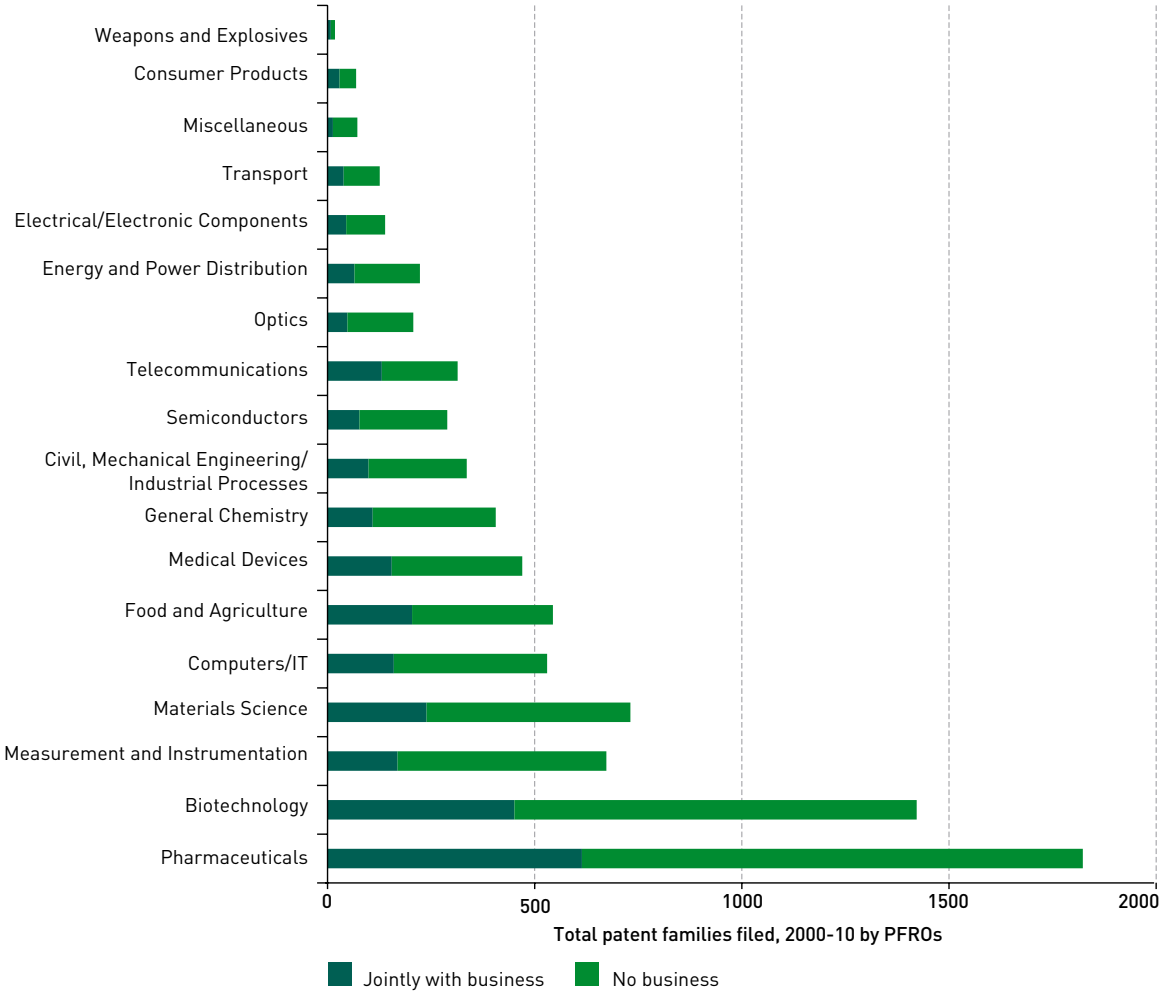
The percentage of research sector R&D funded by business has declined significantly in recent years (Chart 5.6). For the research sector this represents a reversal of the increases that occurred throughout the 1990s and early 2000s. Jointly funded projects between government research agencies and industry shows a continuous downward trend.

Chart 5.6: The proportion of Higher Education (HERD) and Government (GOVERD) expenditure on R&D funded by business or overseas partners

Source: ABS (2010) *Research and Experimental Development, Government and Private Non-Profit Organisations, Australia, 2008-09*, cat. no. 8109.0; ABS (2012) *Research and Experimental Development, Higher Education Organisations, Australia, 2010*, cat. no. 8111.0. Note that HERD data was not collected in 2004.

Chart 5.7 gives an indication of areas where Australia's research institutions (universities, government research agencies and medical research institutes) are producing patents in collaboration with a business i.e. reflecting commercial intent. It shows that while there are a large number of patents being filed for the pharmaceuticals and biotechnology sectors, they are not the most likely to jointly file for patents with a business. Between 2000 and 2010 the proportion of joint research-business patent filings fell from 37% to 25% of all patents filed in that year. Although initial commercial intent and total patenting may be declining, the size of the knowledge market is growing with strong increases in income from licensing, options and assignments of intellectual property (Table 5.1).

Chart 5.7: Total number of patent families filed for by PFROs, by commercial partner, 2000-10



Source: Thomson-Reuters (2012) Special data request by DIISRTE.

Collaboration between research institutions is an important factor of Australia's research quality. A high proportion of Australia's share of the world's best publications (top 1%) is the result of collaboration between research groups domestically. This proportion is growing (Table 5.1; see also Chart 2.1). Interestingly, collaboration in natural sciences and engineering disciplines appears to be more common than in the social sciences and humanities. This may reflect a greater need for sharing technical skills and equipment.

FEATURE: RESEARCH AND INDUSTRY – IMPROVING PRODUCTIVE ENGAGEMENT

Is low collaboration and engagement between the research and industry sectors limiting the productivity dividend? If it is, is this a bad thing?

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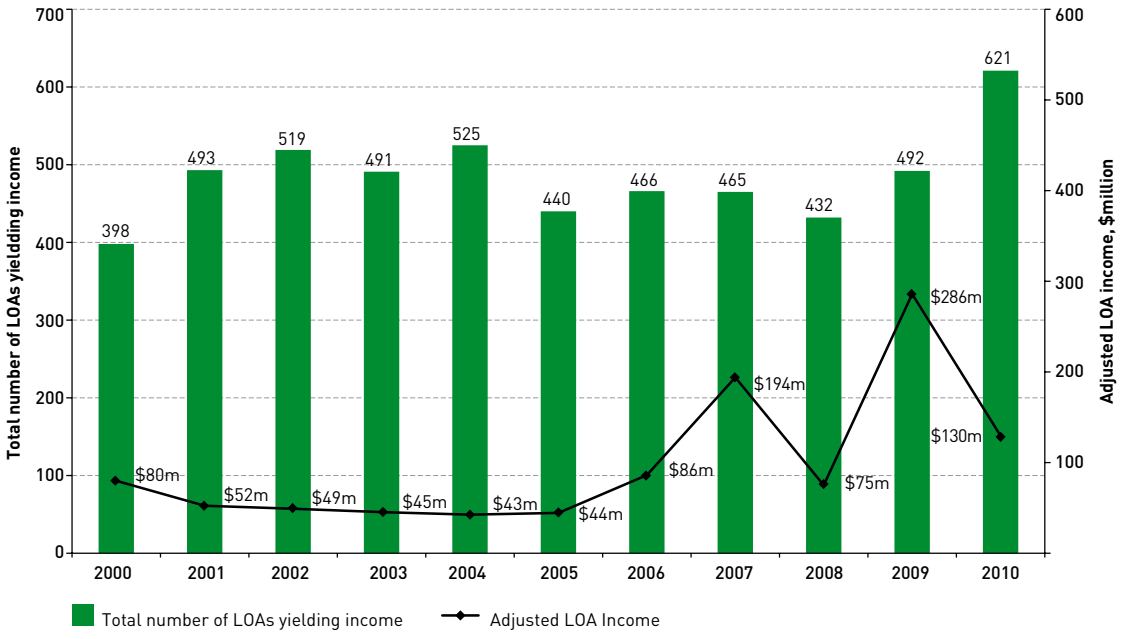
Adelaide Research & Innovation Pty Ltd

Dr Kevin Cullen
CEO
NewSouth Innovations, UNSW

What are the facts?

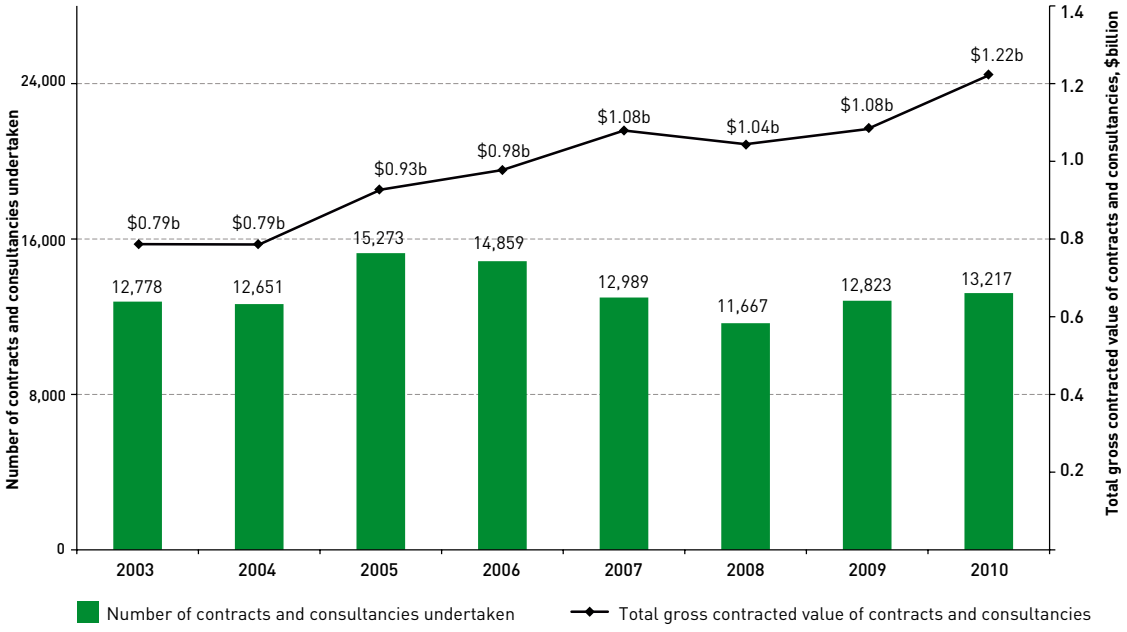
Australia has a history of bemoaning its ability to couple the research and industry sectors. There are often quoted figures showing a low level of engagement (see Table 5.1 and 5.2 of this report). However those figures only tell part of the story. Other metrics point to the value of engagement growing considerably over recent years (Charts F5.1 and F5.2).

Chart F5.1: Numbers and adjusted income from Licences, Options and Assignments (LOAs) of intellectual property, 2000 to 2010



Source: Knowledge Commercialisation Australasia (2012) *Commercialisation Metrics Survey Report 2010*, www.kca.asn.au [Accessed 14 August 2012]. Notes: Adjustment is for income paid to other entities. This metrics survey has been running for over 10 years and is now run in alternate years by KCA and the Department of Industry, Innovation, Science, Research, and Tertiary Education, and its predecessor departments. The 2010 report included responses from CSIRO, ANSTO, and more than half of all Universities – including all members of the "Group of 8" universities.

Chart F5.2: Numbers and gross income from research contracts and consultancies, 2003 to 2010



Source: Knowledge Commercialisation Australasia (2012) *Commercialisation Metrics Survey Report 2010*, www.kca.asn.au [Accessed 14 August 2012].

As these figures show, both commercialisation income from licence and assignment of technology and the value of contract engagement show positive trends. But these measures do not truly demonstrate the "value adding" that contributes a return on investment for the economy that is orders of magnitude greater than the value of those deals. It is important to recognise the nature and breadth of this contribution. It extends far beyond the excellent contributions from success stories, such as *Wi-Fi* and *Gardasil*,[1] into a very broad range of projects adding value to the public and private sector through evidence-based research, policy change and collaboration. Every research institution has its own success stories in this regard and they collectively service a vast array of communities. But most of these contributions are relatively unknown outside of those communities in the broader public. The research sector has a number of motivations for engagement with industry, the drivers are certainly not simply "fee for service". The more compelling arguments are framed around economic development, productivity improvement, and building other benefits for the community. In these ways, through contract, collaborative and commercial engagement, the research sector is able to demonstrate relevance and value to society above and beyond its important role in generation and dissemination of knowledge. The research sector is able to both improve translation of its research to impact, and also lend its skills to the resolution of important challenges in the public and private sector, building on the understanding and innovation that has already occurred in those environments. Simply put, greater partnering is likely to lead to greater success for all engaged in it.

However, notwithstanding recent improvements and increases in the scale and value of this engagement, the level of engagement across the breadth of industry is relatively low when compared to some international examples (see Table 5.1 and Table 5.2). Australia has a world class research base, but transfer of that knowledge into the economy is sub-optimal. So while there are some promising trends, there is room for improvement.

Is this a problem?

Yes. There is widespread recognition amongst policy makers, organisations and business of the need to lift productivity and that productivity growth in Australia has been lagging. Unless we lift ourselves up the value chain we will not thrive in an increasingly competitive global environment. And this challenge is constant as all other economies are continually looking to lift their game. One clear way to lift productivity is through innovation in production and service delivery.

"Trend productivity growth is ... determined by the rate at which new technologies become available, how fast the frontier is expanding, and the rate of improvement in efficiency – how fast the economy is approaching the frontier... economists generally view the likely drivers of multifactor productivity as being R&D expenditure, investment in human capital, and investments in capital equipment that can fundamentally change the way firms operate"[II]

Naturally, not all innovation requires the engagement of the research sector. Much innovation occurs within businesses, or in conjunction between businesses and their customers. There is some exciting innovation occurring in the way these groups interact, for example new models such as Kickstarter.[III] However while innovation will occur with or without the engagement of the research sector, the research sector can play a key role as part of a broader ecosystem. And it is this additional benefit which relatively few businesses are taking advantage of.

We are also in danger of ignoring the benefits that flow back into the research sector from such engagement. This is not a one way transfer of productivity improvement from the research sector to industry (or government): researchers benefit from developing a better understanding of what is relevant to their partners and the marketplace (while not being solely driven by that). Interestingly a recent survey of issues motivating researchers engaged with applied research highlighted the second biggest motivating factor for engagement as being that it provided a good source of research topics and access to new ideas and information (at 20%). The top motivating factor was a desire to see translation of research to impact in the community (46%).[IV]

What can Australia do about it? How can we drive collaboration and engagement?

There is no magic bullet and no single architect. But there is great potential for improved productivity across all sectors by greater engagement, provided that we can get an intelligent combination of market pull and capability push and reduce the costs of collaboration. We need to build a positive culture that recognises the value in this engagement and seeks to leverage its benefits for all.

More could be done to promote knowledge exchange, particularly within Australian SMEs, with a view to economic-development. Below are some international examples of models worthy of consideration.

The **Small Business Technology Transfer** (or STTR) program is a US Government program to support university/business interaction that sits alongside the better known Small Business Innovation Research (SBIR) program. Federal agencies with extramural R&D budgets that exceed $1 billion are required to reserve 0.3% of the extramural research budget for STTR awards to support innovation linkages between small companies and universities or public research institutions. Phase 1 awards are up to US$100,000 total costs for 1 year and Phase 2 up to US$750,000 total costs for 2 years.

The UK has introduced **formulaic "third stream funding"** based on industry engagement metrics. This broad-based approach recognises that university-industry collaboration occurs across a range of activities including consultancy, training, community engagement and collaboration as well as licensing. Universities receive funding based upon their activity across this range. The UK Funding Councils spend in the order of £150m a year in supporting technology transfer, knowledge exchange and community development through this mechanism.

Proof of Concept Schemes have been developed in a number of regions, particularly Europe. One of the oldest, the Scottish Enterprise Proof of Concept program[V] over a 10 year period funded 235 projects for over £47 million. Average projects ran 18 months to 2 years and led to over 800 knowledge intensive jobs being created in companies and universities. Fifty new high-tech companies were formed, 57 license deals signed and over £243 million post-program investment was leveraged.

Other things can be done to address demand-side issues and further improve business investment in R&D. These range from better information, connections, industry/research exchanges, innovation voucher programs and innovation around knowledge exchange models used by the research sector (open innovation, Easy Access and many other approaches directed at reducing friction and transactional costs in the process of engagement).

The research sector needs to challenge itself and the status quo through new business models. We need to focus more on market pull and less on capability push. No single best practice model will work for all: there is plenty of room for diversity and for different organisations to take different paths that best fit their situation and strengths. There is a desire for more collaboration, more open engagement with partners, easier and faster interaction. But beyond that we need to reframe our engagement with the communities we serve: as being one of mutual exchange, rather than one way transfer. There are considerable opportunities for the research sector to learn from counterparts in business and government and gain access to ideas and information (especially "big data") to spur additional R&D work. Notions such as "open innovation" fit well with the fundamental nature of the research sector – which exists to generate and disseminate knowledge. But we need to remain open to developing a more permeable interface - allowing faster diffusion of ideas between sectors – by exchange of people and other means.

We need to educate and inform all sectors better as to the current success stories, to showcase success, build an understanding of the potential value add and increase appetite for engagement. The research sector needs to do a better job of conveying to the public the narratives of benefit to the economy and the community that are being daily delivered from the innovative results of productive partnerships between researchers, business and government. This story is often best told by those who have benefited rather than the research sector itself. Industry can also play a vital role in being more open about its needs. This will help the research sector develop a more problem-solving and customer-centric approach.

Related to this, we need to encourage the development of connections across sectoral divides. There is exciting potential for innovation at the boundaries between research, industry and the public sector in the same way that great innovation often comes from crossing disciplinary boundaries. This needs to be seen as a process of mutual exchange and exploration, not one way transfer of knowledge. Knowledge is "sticky": understanding takes time to develop and is embedded in a specific cultural context relevant to each business or community sector.

The most productive interventions will arise from a focus on the interests of all of the stakeholders in the innovation ecosystem: that is, through collaboration. If Australia wants to ensure its future, it must seize these challenges, and do so not only within its own borders, but with its counterparts around the world.

Footnotes

[I] It is worth noting that peaks in Chart F5.1 are due to CSIRO's Wi-Fi (2009) and Gardasil and Monash IVF (2007).

[II] D'Arcy P & Gustafsson L (2012) Australia's productivity performance and real incomes, Reserve Bank of Australia Bulletin, JUNE Quarter 2012.

[III] www.kickstarter.com [Accessed 20 September 2012].

[IV] Macpherson G, Plewa C, Korff N & Baaken T (2011) Evolution of success factors in university industry linkages. Technology Transfer Conference 2011 abstract, Augsburg Germany; T2 Society USA; http://www.t2s-augsburg.com/t2s-2011-conference/abstracts-of-presentations.html [Accessed 20 September 2012].

[V] www.proinno-europe.eu/.../Peer%20review%20report%20PoC%20Scottish%20Enterprise.pdf.

Global collaboration and productivity

A distinctive feature of global economic integration today is the increasing rate of collaboration with foreign partners on innovation. Global collaboration on innovation is fuelled by interactive cross-border formal arrangements, growing international trade and competition, and greater fragmentation of production processes along global value chains.[173] Evidence suggests that the more businesses engage in international markets, the more their management performance improves with direct flow-on benefits to productivity.[174] Econometric evidence[175] from a panel of industries across 12 OECD countries demonstrates that investment in R&D and investment in human capital stimulates economic growth directly through innovation, but also indirectly by building absorptive capacity that allows a capture of knowledge spill-over benefits from more advanced to less advanced countries.

Research publication data shown in Chapter 2, an imperfect proxy of knowledge generation, suggests that Australia makes a relatively small, but growing, contribution to the total global stock of knowledge (see Table 2.1). Chapter 1 also showed us that businesses tend to invest heavily in machinery and equipment over other complementary investments in innovation and skills. This *technology adoption and/or modification* trend would suggest that innovation in Australia is dominated by the adoption or modification of tested, low-risk innovations from the rest of the world. Australia has always been a net importer of foreign technologies, which means that innovation in Australia often involves combining imported technology, existing knowledge and local problem solving to develop new products and production systems. It has been argued that Australian businesses must continue to build their absorptive capacity to make use of innovations developed overseas.[176] However, the modification of innovations developed outside a business requires a certain level of understanding or sophistication by the recipient business. An analysis of Australia's productivity performance over the 1990s, found that domestic R&D enhanced technology transfer by increasing domestic absorptive capacity, thus allowing countries such as Australia to import and adapt to overseas innovations more easily.[177] Thus businesses need to not only look outside their organisation for innovations but also need to maintain or increase investment in their own capacity to generate and implement ideas.

Table 5.2 shows a range of indicators that measure our performance on international linkage and collaboration. It shows a distinct difference between the relatively poorly ranked business sector and relatively highly ranked research sector.

173 See *Australian Innovation System Report – 2011* (Chapter 4).

174 Bloom N, Dorgan S, Dowdy J & van Reenen J (2007) *Management Practice and Productivity: Why They Matter*, Centre for Economic Performance and McKinsey & Company, July.

175 Griffith R, Redding S & Van Reenen J (2004) Mapping the two faces of R&D: Productivity growth in a panel of OECD countries, *The Review of Economics and Statistics* 86: 883-895.

176 Tressel T (2008) *Does Technological Diffusion Explain Australia's Productivity Performance*, IMF Working Paper, Washington.

177 *Ibid*.

Table 5.2: Australia's performance in global integration against other OECD countries

Indicators	2005	2006	2007	2008	2009	2010	2011	OECD average (latest year)	OECD top five average (latest year)	Gap from the top 5 OECD performers (latest year	Ranking against OECD countries (latest year)	Change from baseline year to latest year (Baseline in bold)
Proportion of GERD financed abroad (%)[1][r]	-	**2.4**	-	1.6	-	-	-	8.2	18.3	91%	22nd	-31%
Share of HERD financed abroad*[2][r]	-	**2.9**	-	2.0	-	2.2	-	n/a	n/a	n/a	n/a	-24%
Number of formal agreements on academic/research collaboration between Australian universities and overseas institutions (%)*[3]	-		3,421	-	**3,493**	-	5,086	n/a	n/a	n/a	n/a	46%
R&D expenditure of foreign affiliates as a % of R&D expenditure of the enterprise[5][r]	-	36	**36**	36	32	-	-	n/a	n/a	n/a	n/a	-12%
Businesses with international collaboration on innovation(% of innovative businesses)[6]	-	**3.6**	-	2.4	-	-	-	18.5	31.0	92%	25th	-35%
Proportion of patents with foreign co-inventors[7]	**15.2**	16.7	15.9	15.7	15.9	-	-	7.6	44.7	64%	26th	5%
Technology balance of payments - (receipts minus payments as a % of GDP)[1][r]	-0.10	-0.03	**-0.14**	-0.20	-0.19	-0.22	-	0.14	1.18	118%	15th	60%
Foreign Direct Investment as a source of technology transfer[8][a]	5.5	5.4	**5.5**	5.4	5.2	5.1	5.0	5	6	11%	15th	-9%
Net gains of skilled persons through migration[9][b][r]	58,200	69,900	80,300	**74,000**	47,300	56,000		n/a	n/a	n/a	n/a	-24%
Proportion of international students enrolled in advanced research programs[10]	18	19	**21**	23	26	29	-	21.08	47.21	No Gap	5th	38%
Share of world's top 1% highly cited publications attributed to international collaboration, All disciplines (%)[4]	-	2.1	**2.2**	2.5	2.7	3.0	3.1	n/a	n/a	n/a	9th	43%
Share of world's top 1% highly cited publications attributed to international collaboration, Social Science and Humanities (%)[4]	-	0.85	**1.01**	1.18	1.43	1.41	1.53	0.98	3.89	61%	6th	51%
Share of world's top 1% highly cited publications attributed to international collaboration, Natural Sciences and Engineering (%)[4]	-	2.29	**2.34**	2.61	2.86	3.13	3.31	2.40	8.68	62%	9th	42%

Sources:
1 OECD *Main Science and Technology Indicators* database, 2012/1.
2 ABS (2010) *Research and Experimental Development, Higher Education Organisations, Australia, 2008*, cat. no. 8111.0.
3 Universities Australia, *International links of Australian universities, 2009* and *2012.*
4 InCites™, Thomson Reuters (2011), DIISRTE special data request.
5 ABS (2011) *Research and Experimental Development, Businesses, Australia, 2009-10*, cat. no. 8104.0.
6 OECD (2010) *Measuring Innovation: A New Perspective*; OECD (2012) *OECD Science, Technology and Industry Scoreboard 2011*; ABS (2012) DIISRTE special data request.
7 OECD (2009) *OECD in Figures*, Paris.
8 World Economic Forum, *The Global Competitiveness Report 2007-08, 2008-09, 2009-10, 2010-11, 2011-12* and *2012-13.*
9 Department of Immigration and Citizenship, DIISRTE special data request.
10 OECD, *Education at a Glance 2007, 2008, 2009, 2010, 2011, 2012*, Paris.

Notes: Indicators with * and in the highlighted rows of the table are the primary indicators applied to measure and monitor progress against the Australian Government's innovation targets. (a) 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". (b) 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. (g) OECD rankings are performed on those OECD countries for which data is available. Individual data availability may vary between indicators. Rankings from previous reports have been revised and may vary as a result. [r] The data may have been revised according to the latest available data. [nd] No new data. [n/a] not available. [-] not applicable. [y] Data is as at earliest year in publication date i.e. 2011 data is from the year 2011-2012 WEF Publication. [e] Excludes agriculture.

In many OECD countries, international collaboration on innovation outweighs national collaboration. In the case of Australia (and a few other countries such as Korea, China and Chile) the reverse is the case (Chart 5.3). Australian industry is doing rather poorly in international collaboration on innovation (Chart 5.3). Australia ranks 25th out of 26 OECD countries. This does not appear to reflect Australia's geographic distance from international markets as New Zealand, with even greater distance, has a higher ranking (17th).

Within Australia, the most common collaboration partners were *suppliers* and *clients, customers or buyers* (both 39%; Chart 5.8). The most common types of overseas collaborative partners for innovation-active businesses were *suppliers* (9%), *competitors and other businesses from the same industry* (5%) and *clients, customers or buyers* (4%). Large businesses were twice as likely to collaborate internationally compared to SMEs. Only 1.1% of innovation-active Australian businesses collaborated with universities and research institutions elsewhere in the world (excluding non-profit research institutions and commercial laboratories) in the period 2008-09.[178]

One feature of global collaboration on innovation is the role played by businesses in cross-border R&D efforts. Businesses that make well-informed and targeted investments in global R&D, based on choice of sites and personnel and with good insights into customer demands, are more likely to secure a better return on their R&D investments than those that invest exclusively in home-grown R&D activities.[179] In the period 2007-08, cross-border partnerships accounted for more than one-fifth of total business R&D in most OECD members.[180] Australia performs relatively poorly in terms of international collaboration on R&D by OECD standards, particularly in attracting direct R&D funding from abroad (Table 5.2).

The acquisition of new foreign technology and know-how through the import of high-tech equipment, foreign direct investment, trade in IP and attracting highly skilled foreign researchers and workers also fosters innovation and productivity growth, and serves as a major source of disembodied knowledge diffusion.[181] International technology flows on innovation and productivity growth is reflected in knowledge being increasingly implemented in a country other than the one in which it was developed.

Technology receipts from patents and licences, and payments for R&D services and royalties are indicators of international technology flows. According to the OECD, in almost all countries for which data is available, transactions involving royalties and licence fees grew on average more than the rate of GDP growth over the decade 1999-2009.[182] Table 5.2 indicates that Australia's performance is poor relative to other OECD countries. For example, the proportion of patents with foreign co-invention has Australia ranked 26th out of 30 OECD countries. Data indicates that Australia's technology imports outweigh its exports between 2007 and 2010, making Australia a net importer of technology. Measured against technology balance of payments as a percentage of GDP, Australia's OECD ranking was 15th. In this period, Australia's payments for technology acquisition increased by almost 25% from around $6 billion to around $8 billion. Australia's

178 ABS (2012) Data analysis commissioned by DIISRTE; Collaboration with universities and other research institutions excluding commercial by employment size ranges, 2008-09.

179 INSEAD (2011) *The Global Innovation Index 2011: Accelerating Growth and Developmen*t, http://www.globalinnovationindex.org/gii/main/previous/2010-11/FullReport_10-11.pdf [Accessed 2 November 2012].

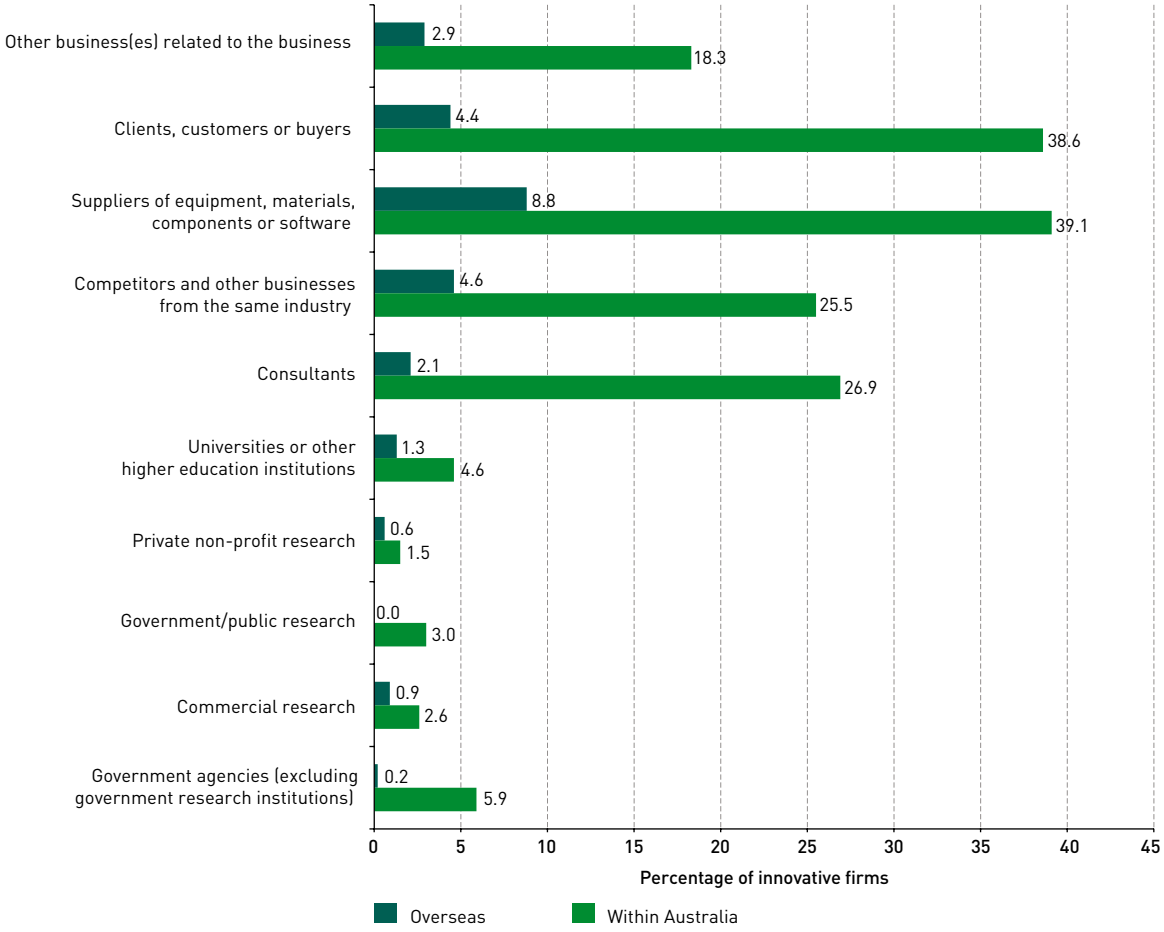
180 *Ibid.*

181 *Ibid.*

182 *Ibid.*

technology exports, however, increased by around 10% in the same period. In 2010 Australia's net inflow of FDI was around $26 billion, which was a 40% increase compared to 2009, yet around 30% less than 2008. Foreign direct investment as a source of technology transfer appears to have declined between 2005 and 2011 (Table 5.2).

Chart 5.8: Collaboration for innovation, by location of organisation, by type of organisation collaborated with, 2010-11



Source: ABS (2012) *Innovation in Australian Business, 2010-11*, cat. no. 8158.0.
Note: Businesses could identify more than one location and/or type of organisation.

International engagement by the research sector

The globalisation of higher education and research systems is illustrated in part by the global mobility of academics and university students. The movement of holders of doctorate degrees and PhD students from one country to another is an indicator of internationalisation of research. Australian universities fare particularly well in attracting foreign students (Table 5.2). Australia's higher education and research system has evidently become more globalised over the past couple of decades with an influx of international students, and with more collaborative research between Australian and foreign universities. International funding of Australia's research sector R&D (Chart 5.6) shows a generally positive trend from a low base (Table 5.2). This trend is in alignment with Australia's growing share of the world's top 1% of research attributed to international collaboration.

Global scientific and technological collaboration also provides access to a larger pool of expertise that enables the international research partners to produce joint scientific publications and/or inventions with greater impact.[183] Research publications involving international collaboration make up the majority of Australia's world's best publications (top 1%) and this proportion has grown over the last six years, rising from 2.14% in 2006 to 3.14% in 2011 (Table 5.2; see also Chapter 2 discussion). Latest data indicates, however, that Australia's ranking has fallen from 7th to 9th between 2008 and 2011.

Why don't businesses collaborate more?

Given the benefits described above, why don't more businesses in Australia collaborate on innovation? Although there is no systematically collected data on barriers to collaboration, there is research that has identified barriers to collaboration for the purposes of innovation. Indeed, collaboration carries risk and organisations need to, not only find the right partner, but also to have the right alignment that enables effective communication e.g. shared goals, values and cultures.

The tendency to network and collaborate on innovation is higher for organisations that invest more in training, that have better qualified management and staff, and use more formal or structured processes to capture and exploit innovation opportunities.[184,185] Thus the propensity to network and collaborate is related to the concept of absorptive capacity[186] which is defined as *the intent and set of organisational routines and processes, whereby organisations recognise, acquire, assimilate, transform and exploit knowledge from external sources*. Absorptive capacity is a function of an organisation's strategic intent; existing resource, skill and knowledge base; internal routines; management competencies, and culture.[187] Without these capabilities, recognition of an opportunity to collaborate is of little value.[188] Absorptive capacity building through collaboration, amongst other activities, does not occur without effort. It is a matter of will and deliberate policy on the part of managers.[189] The Chapter 1 discussion of poor management competency leading to poor innovation and productivity outcomes[190] also applies here.

It is often impossible for managers to assess the value of collaboration without first having done it. Understandably potential partners are often unwilling to share information as it may allow other businesses to walk away with free and useful knowledge. As a result, potentially productive partnerships may fail to be realised. Managers are also often unwilling to commit to the high upfront costs necessary to develop collaborations as the benefits are often realised over the long term and may not be easily identified. Even when they see a benefit, managers may not have the capabilities necessary to coordinate and maintain inter-business networks.[191]

183 Smith K & West J (2005) *Australia's Innovation Challenges: The key policy issues,* Submission to the House of Representative Standing Committee on Science and Innovation (HRSCSI) Inquiry into Pathways to Technological Innovation.

184 Gray C (2006) Absorptive capacity, knowledge management and innovation in entrepreneurial small firms, *International Journal of Entrepreneurial Behaviour and Research* 12: 345-360.

185 Arnold E, Allinson R, Muscio A and Sowden P (2005) *Making Technological Knowledge Work: A study of Absorptive Capacity of Irish SMEs,* Technopolis report for Forfás, Ireland http://www.forfas.ie/media/forfas050315c_making_tech_knowledge_work.pdf [Accessed 2 November 2012]

186 Cohen WM & Levinthal DA (1989) Innovation and learning: the two faces of R&D. *Economic Journal* 99: 569-596.

187 Scott-Kemmis D, Jones AJ, Arnold E, Chitravas C & Sardana D (2007) Absorbing Innovation by Australian Enterprises: *The Role of Absorptive Capacity,* Department of Innovation, Industry, Science and Research, Canberra.

188 Scott-Kemmis D, Jones AJ, Arnold E, Chitravas C & Sardana D (2007) *op. cit.;* Easterby-Smith M, Graca M, Antonacopolou E & Ferdninand J (2005) *Absorptive Capacity: Tales from the Field.* Evolution of Business Knowledge working paper, Economic and Social Research Council, UK.

189 Easterby-Smith M, Graca M, Antonacopolou E & Ferdninand J (2005) *Absorptive capacity: Tales from the field,* Evolution of Business Knowledge working paper, Economic & Social Research Council, UK.

190 Bloom N, Dorgan S, Dowdy J & van Reenen J (2007) *Management Practice and Productivity: Why They Matter,* Centre for Economic Performance and McKinsey & Company, July.

191 OECD (2010) *The OECD Innovation Strategy: Getting a Head Start on Tomorrow,* Paris.

Case studies

Victorian company collaborates to expand and diversify its business

Starpharma is using a Victorian Government voucher to explore the use of its proprietary dendrimer technology to produce agrochemicals that are more efficient and more effective than existing chemicals.

Dendrimers are man-made, nanoscale compounds that have applications in their own right or when used in combination with other compounds. Starpharma's dendrimer technology has been used in the pharmaceutical sector where the dendrimers can bind to drugs and biological compounds to enhance their performance.

Starpharma are now investigating the performance of its Priostar® dendrimer technology in the agricultural sector. It is anticipated that the Starpharma technology will offer a number of unique features that reduce cost and decrease the environmental impact of the chemicals. In particular, the technology has the potential to:

- improve the ability of chemicals to penetrate the soil;
- improve delivery of chemicals to the plant to enable healthier growth and better fight disease;
- enable farmers to use less agricultural chemical while retaining effectiveness.
- decrease the need to reapply sprays; and
- improve operator safety.

Proving the performance of its dendrimer technology will allow Starpharma to expand into new markets beyond its current pharmaceutical focus and make the company well placed to capture opportunities in the $40 billion agricultural chemical market.

Starpharma received the $250,000 voucher from the Victorian Government's Small Technologies Industry Uptake Program to collaborate with specialist innovation partners to commercialise the technology. Boron Molecular is producing the Priostar® dendrimers for the trials and Eureka! AgResearch is using greenhouses to test the dendrimer agrochemical preparations for efficacy.

Websites for further information:
www.starpharma.com,
www.innovation.gov.au/AISreport2012/program_compendium
www.innovation.vic.gov.au/stiup.

The role of the intermediary as a catalyst for change: The Desert Peoples Centre

The Desert Peoples Centre has been designed as a catalyst for change in desert Australia. One of the ways we are working to achieve this aim is the support of innovation and entrepreneurship to create social value. Providing a hub and conduit for resources and information, our remote location demands a 'one-stop-shop' approach. This role is an opportunity and a challenge for an intermediary.

Social entrepreneurship and innovation are by no means new phenomena in remote Australia. What is new is the scale of activity, the emergence of common language and practice and the growing focus on supporting these fields, locally, nationally and globally. Intermediaries in this space can be characterised as responding to a social challenge: the need for targeted and tailored support for social-purpose ventures. A healthy and enabling ecosystem requires resources and approaches that differ from traditional business or charity.

Working with people motivated by social purpose and the ventures they design, build and run, can be a deeply satisfying process. The passion and belief that they can shape a better world is often contagious. The ability to spread this belief to build support is a key characteristic of a 'change maker'. For example, Max and Ruth Emery run Desert Garden Produce Aboriginal Corporation, a bush foods farm based south of Alice Springs. That this is a successful enterprise in a very remote Aboriginal community is worth celebrating; that they have worked their way into a major supermarket supply chain and collaborate with international universities on research is testament to a tenacity and perseverance that is rarer still. The hub is working with Max and Ruth to develop a model for sharing their success with other remote communities, for economic gain and the benefits of access to fresh produce.

Ian Trust (Chair, Wunan Foundation; Board Member, Indigenous Land Corporation and Indigenous Business Australia), speaking at the Desert Peoples Centre. Image by Dylan McDonald.

In remote Australia, the complexity of creating sustained social change and escalating calls for effective demonstration of social impact are driving the imperative for common metrics and systems. Part of this shift is the growing involvement of the corporate and philanthropic sectors; another is the opportunity of technology. To meet these demands and maximise the potential benefits these interfaces require constant management. This can be challenging for organisations that are culturally and geographically disparate from prospective partners and where 'digital inclusion' is patchy. Together with the University of Sydney, and with support from the Northern Territory Research and Innovation Board, we are developing and trialling approaches for measuring value creation to suit remote enterprises and take advantage of digital tools.

These are all dynamic areas that illustrate the valuable role intermediaries play in creating positive social change. Collaborating to catalyse someone's idea, or supporting an organisation to sustain and/or scale their impact, these are measures of success. Ultimately, the role of the intermediary is to lower the threshold for people to engage with the social challenges that confront them.

Websites for further information:
http://deserthub.org
http://www.desertpeoplescentre.org.au

Scott Reef partnership

A long-standing collaboration between Woodside, the Australian Institute of Marine Science (AIMS) and Western Australian Museum (WAM) has demonstrated the benefits of collaboration between industry and publicly funded research agencies and resulted in world class research outcomes in the form of benchmark data about the health of the Scott Reef, and the partners Woodside and AIMS being the recipients of awards as a result of this collaboration. This partnership has improved understanding of biodiversity and ecological function of the tropical marine communities of Western Australia. This understanding has developed through a long-term investment (since 1994) in scientific research and involved the sharing of knowledge from this research for the benefit of the industry partner, the scientific and wider community

Since 1993, AIMS and Woodside (on behalf of our Browse Joint Venture Partners) have partnered to undertake more than 40 expeditions to the offshore atolls of the Kimberley to understand the biology, ecology and oceanography of these offshore environments. This work has resulted in over 20 international peer-reviewed publications and has been critical in approval and implementation of early appraisal works at Scott Reef.

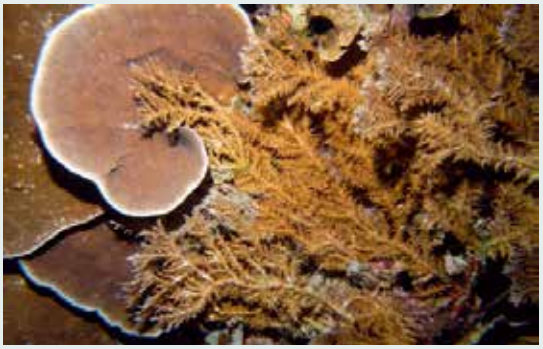
AIMS recently completed a major four-year research program (2008-2012) which was funded by Woodside on behalf of the Browse Joint Venture. The "Scott Reef Research Project" was fully funded and was specifically designed to deliver research that would help inform future development decisions. At a cost of more than $30 million, the project was the largest baseline environmental study undertaken by AIMS for the oil and gas industry. It has provided new insights into the biodiversity, dynamics and resilience of a unique and remote coral atoll system off the northwest continental shelf of Australia.

In May this year the Australian Petroleum Production and Exploration Association (APPEA) recognised the commitment of Woodside to this collaboration with the 2012 APPEA Environment Award.

The knowledge generated through this research provides wins all round. Industry as a user of Australia's coasts and oceans obtains comprehensive and detailed information needed to support its operations, regulators have access to improved baseline information to support decision-making and, more generally, Australia benefits from an improved understanding of the biodiversity and processes driving our valuable marine resources.

In addition, as part of this collaboration AIMS developed and implemented a new approach to safety management. This was awarded the Best Workplace Health and Safety Management System by Safe Work Australia in 2009 and has resulted in significant improvement in AIMS safety practices and performance.

Website for further information:
www.aims.gov.au



CHAPTER 6

Public sector and social innovation

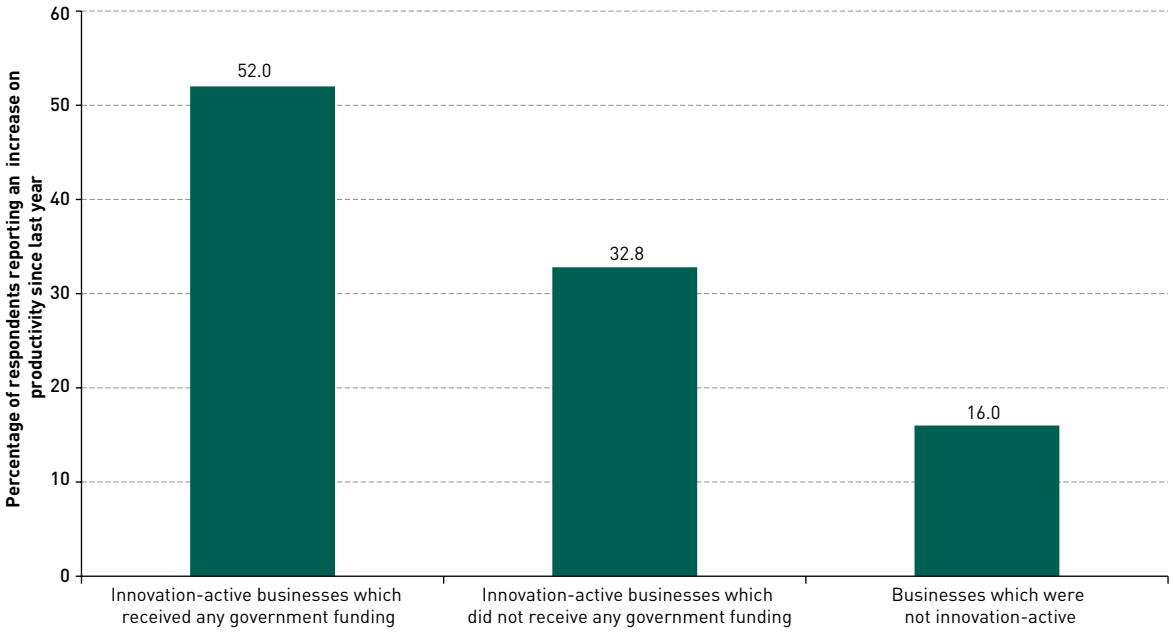
Governments can create conditions for a productive economy and society. Governments both innovate themselves and support innovation by providing infrastructure, services and programs for the community, businesses and individuals.

These government actions and investments account for 35% of GDP in Australia.[192] Thus, it is imperative that governments be innovative in the development of policy and the delivery of services that provide better quality of life for the community.

Chart 6.1 indicates that there is a positive correlation between receipt of government assistance and increases in business productivity for businesses that are innovative. Innovators that receive government funding are 1.6 times more likely to report increases in productivity than innovators that did not receive government funding.

While governments can create frameworks and incentives that support and stimulate innovation, if these are developed in partnership and collaboration with other sectors, this will assist in the delivery of programs, products and services that better meet government, provider and community needs.[193] Such an approach supports equitable opportunities for participation and has a higher likelihood of addressing complex social, environmental and cultural problems (see this chapter's Feature).

Chart 6.1: Business productivity performance by innovation status, by government assistance, 2008-09



Source: ABS (2012) DIISRTE special data request.

The Australian Government recognises that innovation and productivity in government are vital and that improvements made by the Government can flow on to other areas of the Australian economy and society. Therefore, creating and maintaining an environment in which innovative ideas can be generated, tested, implemented, diffused and evaluated is a priority of the Australian Government.[194]

192 Estimate on general government expenditure as a share of GDP, Department of Innovation, Industry, Science, Research and Tertiary Education.

193 Advisory Group on Reform of Australian Government Administration (2010) *Ahead of the Game: Blueprint for the Reform of Australian Government Administration,* March; http://www.dpmc.gov.au/publications/aga_reform/aga_reform_blueprint/index.cfm [Accessed 20 September 2012].

194 Australian Public Service Management Advisory Committee (2010) *Empowering Change: Fostering Innovation in the Australian Public Service,* Canberra.

Internationally there is a growing awareness and involvement across all sectors in the area of social innovation. Social innovation and social technologies are permeating different sectors of society. Considerable productivity gains (of the order of 20-25%) are expected to come from the use of social technologies.[195] There is also a greater focus on how the three sectors: government, business and the so-called third sector, can, through collaboration, gain better value from the resources committed to addressing issues that are social, cultural and environmental in nature.[196]

This chapter looks at developments in innovation in the public sector in Australia including efforts to measure its impact. New developments in government policies and programs to encourage public sector and social innovation are detailed in the compendium of program updates accompanying this report at www.innovation.gov.au/AISreport2012/program_compendium. More detail on the compendium can be found in Appendix 1.

FEATURE: THE CO-PRODUCTION OF PUBLIC AND SOCIAL INNOVATION

Professor Peter Shergold AC
Chancellor
University of Western Sydney

Image provided by Professor Shergold's office

In the Australasian colonies of the nineteenth-century, community-driven organisations: co-operatives, mutuals and friendly societies were major forces of economic growth and social development. They were businesses founded on self-help. They were driven by mission. By the second half of the twentieth-century, however, the State and the market (and the tensions between them) dominated political life. Many non-government organisations became defined by their charitable status.

Now significant changes are afoot once more. The community (a.k.a. Civil Society) is undergoing a renaissance. The changes are largely unrecognised and unheralded but of significant consequence.

It is ironic that at the very moment an Australian Charities and Not for Profit Commission is being established, civil society organisations are being reborn as neither of the above. Many are re-conceiving themselves as social enterprises, pursuing their social, cultural or environmental goals in a manner which affords a prospect of financial sustainability. Operated along commercial lines, social businesses now seek a better world through engaging in trade. The goal is not the accumulation of profits for distribution to owners and share-holders but surpluses which can be reinvested in social innovation.

Social entrepreneurship is just one dimension of a changing world. The private sector is also rearticulating its role in society. Corporations increasingly recognise that they need a 'licence to operate'. They have moved beyond the 1990's embrace of triple bottom line reporting (profits, people, planet) and now routinely report on their broader commitment to corporate social responsibility. A few already identify themselves as 'shared value' companies, arguing that over the long-term they create both financial and societal returns. Being a good 'corporate citizen' is no longer perceived merely as a reputational bolt-on to core business strategy.

To the extent that companies provide support to community organisations, they increasingly do so not as philanthropic benefactors but as social investors. Both they, and the community-based organisations they fund, increasingly recognise the need to measure the social returns on that investment. Social auditing is coming of age.

Customers, suppliers and investors understand this. Many financial institutions now manage funds that cater to socially responsible investors who wish to screen their investments in accord with their principles, seeking to avoid harm, promote sustainability and take account of a company's environmental, social and governance (ESG) arrangements. A growing minority of ethical consumers are willing to pay

195 McKinsey Global Institute (2012) *The social economy. Unlocking value and productivity through social technologies,* July.

196 Leadbeater C (2007) *Social enterprise and social innovation: Strategies for the next ten years,* Cabinet Office UK. See also the following websites: http://www.nesta.org.uk; http://www.youngfoundation.org; http://www.socialedge.org/discussions/social-entrepreneurship/cross-border-social-innovation; http://www.csi.edu.au; http://www.tacsi.org.au;http://www.socialinnovation.se/en/ [Accessed 20 September 2012].

more for goods and services that represent 'fair trade'. There is a renewed interest in co-operative forms of enterprise, from credit unions and community banks to recycling operations and wind farms.

In short, the 'not-for-profit' sector is a raucous cacophony of organisational innovation. Why is it then that governments just don't seem to get it? Why is it that the relationship between the public and community sectors remains mired in the conceptual framework of the past?

Community organisations have never been so important to the delivery of human services for the governments. The Productivity Commission estimates total direct funding flows from governments to not-for-profits at $26 billion each year. Yet the cross-sectoral relationship remains constrained by the rhetoric of outsourcing, in which community organisations (the providers) are paid (often inadequately) to deliver programs on behalf of governments (the purchasers).

Creating a market for public services, by placing responsibility for program implementation with a diversity of community providers, had the potential to generate an extraordinary wave of public and social innovation. Contestability should have inspired new opportunities for social enterprise.

Instead, entrapped by their own risk aversion, governments have imposed on community organisations a heavy burden of regulatory requirements. Public servants too often see their jobs as managing contracts not relationships. Public accountability focuses heavily on compliance rather than performance. Here are two simple questions. Why bother to outsource the delivery of public policy if, through restrictive service agreements, governments then seek to make all providers operate in a standardised fashion? Why stifle competitive innovation?

Don't get me wrong. The ever-greater participation of civil society organisations in the implementation of the policies of the State has been a good thing. It generally offers better value-for-money, enabling higher quality service delivery from organisations that care about (and often advocate for) their clients. The disappointment is that it could have been a very much greater thing – but only if the relationship had been conceived as a genuine partnership, based on principles of trust and mutual respect.

Not all is lost. Governments are coming to recognise the value of collaboration. They are looking for ways by which to improve the relationship with the community organisations they contract. Yet the dimensions of the challenge go beyond governments embracing the inclusive rhetoric of partnership, making more generous payments and slashing bureaucratic red-tape. The biggest and most exciting potential is to embrace collaboration between the sectors as a means of generating a wave of public and social innovation.

The starting point for a new innovation system is to recognise that public policy is not an evidence-base in search of an elegant solution. Innovation cannot depend only upon some carefully constructed 'mind lab' designing new policy initiatives. Government policy, necessarily developed in an iterative manner in the real world of political contest, is only as effective as the way in which it is delivered.

Yet too often the wisdom of the front-line, whether it is public servants or contracted community workers, is unrecognised or dismissed. If one is looking for the 'crowd' in which one can source public innovation, look to those who have experience of delivering policy at the community level. Today much of that expertise sits with contracted community organisations. Unfortunately they generally only get to participate in the political process when policies have already been decided, administrative guidelines framed and the contracts written.

Most community organisations are cash-strapped. Their resources are nearly always less than their capacity to scale their ambitions. Perhaps as a consequence they generally evince a far greater appetite for risk than the governments and public services to which they are contracted. Governments now need to harness (and support financially) their drive to innovate.

Collaboration is necessary but not sufficient. What is needed is co-production. Innovation is far more likely when public policy is jointly designed and managed. The community organisations that are contracted to deliver public services should be given every opportunity to be engaged in the task of developing government policy. Programs to help disadvantaged Australians lead a full civic life should be designed on the basis of the experience of the social enterprises which implement them.

At the same time, citizens should be empowered to take control: where possible, beneficiaries should be enabled to self-manage the public services which are provided to them. More programs should be tailored to place. People and communities, given a chance to self-direct government support, will find ways to do things differently (and make more effective use of scarce public funds).

Co-production does not diminish the role of the State. It means that elected governments continue to set budgetary parameters and policy directions but then encourage contracted organisations, paid on the basis of outcomes, to find new approaches to deliver their goals. It means allowing individuals and communities to do things their way. In effect a competitive market of 'demonstration projects' can be engendered. Pilot programs, so often embraced as an excuse for inaction, can actually be used to trial innovation.

This requires stripping away the micro-managerial interventions by which public servants seek to control the behaviour of their contracted agents. The transformation will be assisted by bold new approaches to social financing, such as the issuance of social benefit bonds, by which social enterprises (and their private sector investors) are paid by governments a share of the public savings that their innovations generate.

Productivity in the public sector means finding the most cost-effective way of delivering policy objectives. Sometimes that's tough. Think, for example, of the challenge of providing a generous safety-net of welfare-support whilst promoting workforce participation. What is clear is that innovation requires breaking the mindset that a one size solution will fit all beneficiaries.

To change the implementation of publicly-funded services on a grand scale is not easy. It requires countenancing diversity in the manner in which the policy directions of government are delivered. The design and delivery of public programs need to be framed to encourage the prudent pursuit of risk. Social enterprises, with public services as facilitators, and supported by private sector investors and philanthropists, should be rewarded for innovation. Communities and individuals should be freed to make more decisions on their own behalf.

The result will be innovation based on co-production. A beneficial side-effect of such a system will be the creation of social capital, greater participatory engagement in democratic processes and the enhancement of civil society.

There are two words that can usefully summarise this possible future: network governance. Cross-sectoral collaboration, informed by front-line experience, represents the best hope for generating an Australian Innovation System that progressively can improve the creation of social and public impact.

Public sector innovation

Capital constraints are major barriers for both the private and public sectors. However, the environment in which innovation occurs is considerably different between the public and private sectors mainly because of the differing mix of commercial and political imperatives.[197] One important difference is the tolerance of failure between public and private sectors. In the private sector failure is assumed and accepted as part of the innovation process as long as the result of commercial success outweighs losses over the longer term. By contrast, political considerations mean that the public sector does not accept the rates of failure that exist in the private sector.[198] Aversion to risk and change by public service managers are some of the barriers to innovation reported by public servants (at around 40%).[199]

Assessments of innovation in the Australian Public Service are being undertaken by the Australian Public Service Commission twice a year for the annual State of the Service Report.[200] To date, the 2010-11 survey is the most comprehensive innovation survey undertaken by the Commission. It shows that while innovation was a consideration amongst many Australian public service agencies, there remain barriers to achieving an innovative culture in the workplace. The 2011 State of the Service report indicated that:

- 84% of agencies reported that they had introduced significant innovations in areas that included human resources, policy development, and program design and service delivery;
- 50% of employees agreed their workgroup had implemented an innovation in the preceding 12 months (31% disagreed and 19% were 'not sure');
- almost 90% of employees were always looking for better ways to do things;

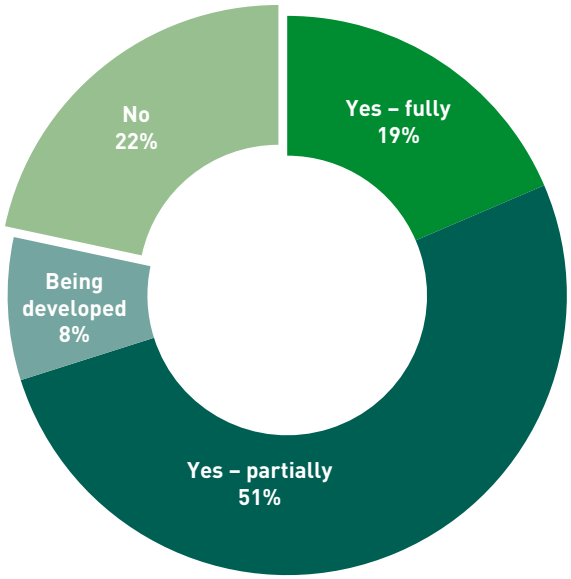
197 Kay R & Goldspink C (2012) *What public sector leaders mean when they say they want to innovate,* Incept Labs, Sydney.
198 *Ibid*.
199 Australian Public Service Commission, *State of the Service Report 2010-11,* Canberra.
200 For further information, see www.apsc.gov.au [Accessed 20 September 2012].

- 50% of employees agreed that their current agency encourages innovation and the development of new ideas; and
- 53% of employees believed that there are barriers to innovation in their workplace—the greatest barrier being budget restrictions followed by unwillingness of managers to take risks.

International comparisons between public sector innovations are limited. There is currently no internationally agreed framework for measuring public sector innovation. Data from the USA Partnership for the Public Sector, which attempts to measure the innovativeness of the USA federal government, shows similar results to Australia. In the USA case, 91% of employees indicated that they were constantly looking for ways to 'do my job better'. This figure is 88% for Australia. Similarly, while 39% USA public sector employees indicated that creativity and innovation are rewarded in their agencies, 30% of their Australian counterparts pointed out that 'my workplace has a reward or incentive programs that encourage innovation'.

The State of the Service data shows that 70% of Australian Public Service agencies (fully or partially) have strategies to encourage innovation (Chart 6.2). However, less than 20% of the Australian Public Service agencies have fully implemented these strategies. This means that the strategies have been implemented only in part of the agency, or they are in the process of being implemented.

Chart 6.2: Existence of strategies to encourage innovation

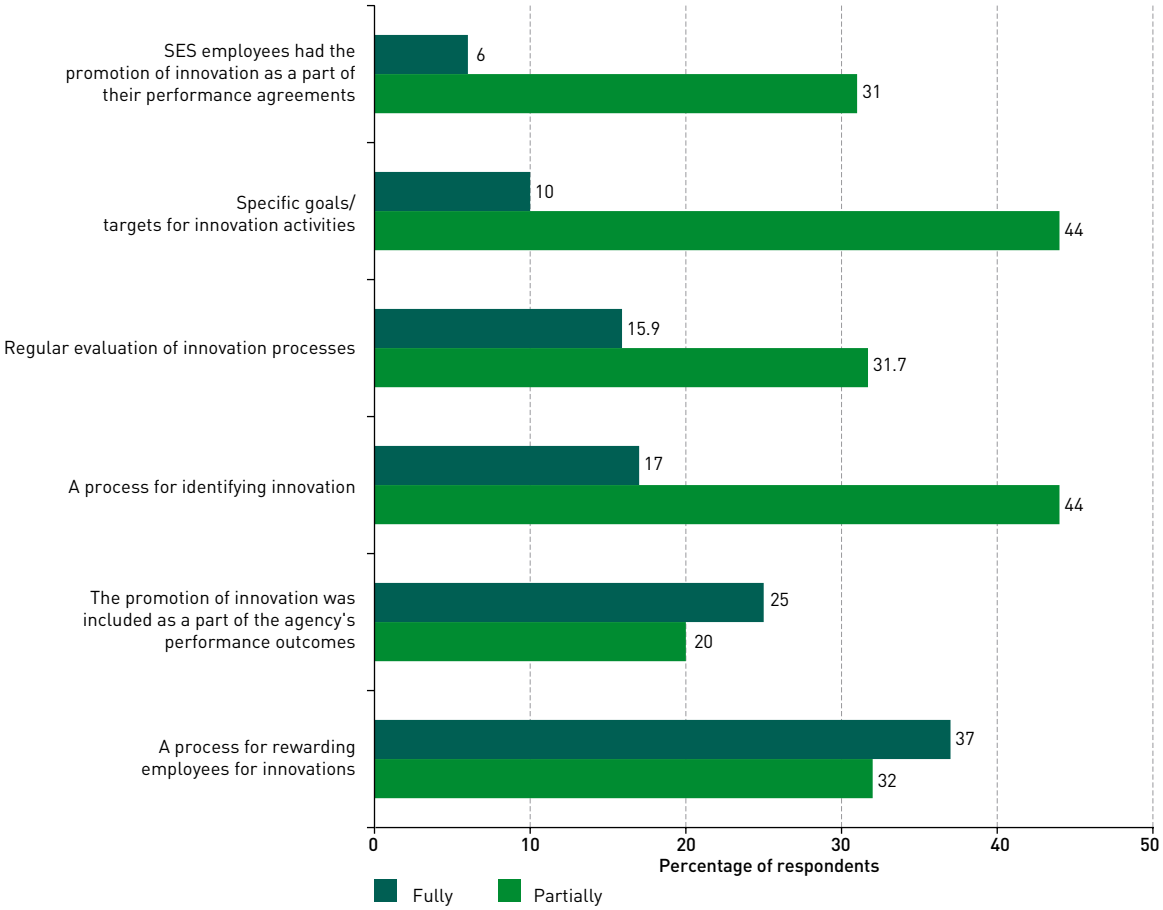


Source: Australian Public Service Commission (2011) *State of the Service Report 2010-11*.

Chart 6.3 details the kinds of strategies that Australian Public Service agencies use to encourage innovation, with the most common being 'rewarding of employees'. A smaller proportion of Australian Public Service agencies have fully developed strategies to identify innovation, setting specific targets for it, or doing regular evaluations of innovation. It is interesting to note that while aversion to risk and change are reported as high barriers to innovation, only 6% of organisations currently have innovation as an aspect of their managers' performance agreements. There appears to be a larger number of organisations in the process of incorporating new strategies for innovation, most likely as a result of recent pushes by the heads of agencies for greater innovation in the public service. This is likely associated with the release of the APS Innovation Action Plan[201] in mid 2011 signed by all agency heads.

201 http://www.innovation.gov.au/INNOVATION/PUBLICSECTORINNOVATION [Accessed 20 September 2012].

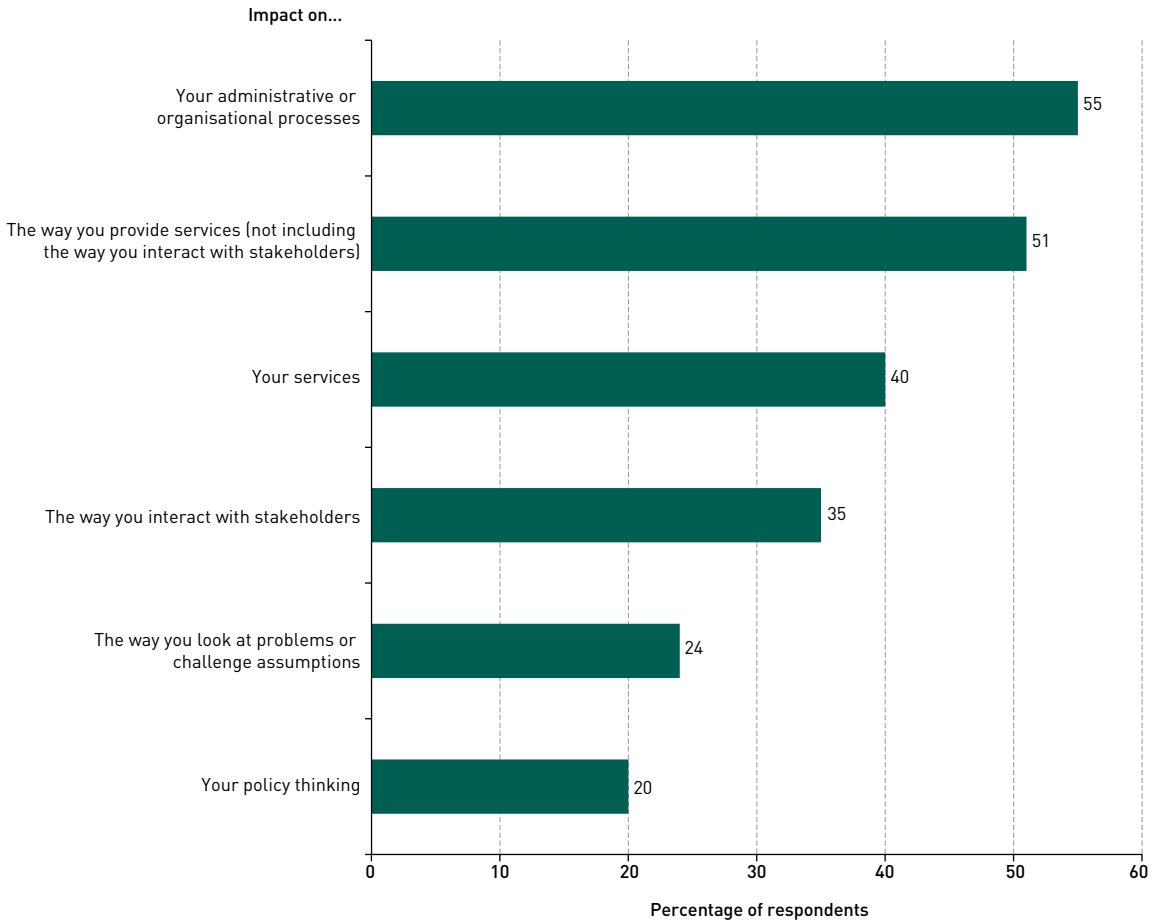
Chart 6.3: Strategies for promoting innovation in the Australian Public Service



Source: Australian Public Service Commission (2011) *State of the Service Report 2010-11*. SES refers to APS Senior Executive Service managers.

Chart 6.4 shows that the impact of innovation in the public sector is mainly associated with tangible outcomes such as improved organisational and administrative processes or delivery of services. Impacts related to policy are more limited, or may be more difficult to identify. The data suggests that innovation in the public service may be more 'fluid' than in the private sector, where impact can be more easily identified in concrete metrics such as increase in sales of new products. Improved outcomes in terms of interaction with stakeholders, policy thinking and new ways of looking at problems and assumptions are difficult to identify or distinguish from more routine program delivery activities in the public sector even though a higher level of value added and intellectual novelty may be associated with this work.

Chart 6.4: Employees' assessment of the impact of the most significant innovation on work programs



Source: Australian Public Service Commission (2011) *State of the Service Report 2010-11*.

Case studies

Social Innovation@ DEEWR - The Children's Ground initiative

The Children's Ground initiative has been co-developed by the founding CEO, Ms Jane Vadiveloo and the Social Innovation Group in the Australian Government's Department of Education, Employment and Workplace Relations (DEEWR).

Children's Ground Ltd is a recently established not-for-profit entity offering a new approach to help children facing the greatest levels of disadvantage in Australia to reach their full potential. Its focus is on driving inter-generational change in communities to help break the cycle of poverty and promote community well-being. It does this through an innovative, education-based service model which supports children, and their families, throughout childhood and into early adulthood. A key feature of the model is its commitment to working in partnership with local leaders to design and deliver services that are specific to the needs of a community.

The Children's Ground approach is based on initiatives such as Harlem Children's Zone in the USA which has established an impressive track record in helping children out of poverty by adopting a long term, place-based approach to drive social change.

The Mirra people living in Kakadu, West Arnhem in the Northern Territory are the first community to adopt the Children's Ground model. Through their organisation, the Gundjeihmi Aboriginal Corporation, they are committing significant resources and money to deliver Children's Ground in their region.

Over the course of its development, Social Innovation Group has worked with Ms Vadiveloo to help develop the Children's Ground model and its establishment as an independent entity. The Children's Ground Board is now driving the growth and future funding of the organisation.

A 'Community of Practice in Government' has also been established as a way for Children's Ground Ltd and governments to share, network and learn together so as to translate policy and best practice into reality

Website for further information:
www.deewr.gov.au/EMPLOYMENT/PROGRAMS/SOCIALINNOVATION/Pages/default.aspx

The Australian Centre for Excellence in Public Sector Design

As part of a consortium, the Department of Innovation, Industry, Science, Research and Tertiary Education has established an Australian Centre for Excellence in Public Sector Design. The Centre will demonstrate the value of design in driving innovation in the Australian Public Service, and help equip Australian Public Service staff with design expertise.

The Centre is supported by the Departments of Innovation, Industry, Science, Research and Tertiary Education; Immigration and Citizenship; Education, Employment and Workplace Relations, Prime Minister and Cabinet, the Australian Taxation Office, the Australian Public Service Commission and the Australian National University. The Centre is overseen by a board with an independent chair, with three secretaries, an agency head, a private sector design and innovation thinker, and the Centre's CEO, Ms Jane Treadwell.

The Centre will draw on the experience of like-agencies such as Denmark's MindLab and Finland's Helsinki Design Lab, and in association with the Australian eco-system of interested design experts, businesses, public sector agencies, not-for-profits and tertiary education institutions will expand the use of strategic design practice to understand, challenge and explore new answers for complex problems.

The Centre was endorsed by the members of the Australian Public Service Secretaries Board in response to the recommendations of the *Empowering Change: Fostering Innovation in the Australian Public Sector* and the subsequent APS200 project on public sector innovation.

Blog for further information:
http://innovation.govspace.gov.au/tag/centre-for-excellence-in-public-sector-design/

Remote Areas Licensing Program - WA Government

There are a range of issues and barriers facing people living in remote areas in their endeavours to obtain and retain a driver's licence, including sustainability of licensing materials and accessibility of services. However, driving in these areas is an essential part of life as there are few alternatives available for travelling the often large distances required. The WA Department of Transport (DoT) has also determined that there is an inequitable distribution of licensed driving instructors throughout the remote areas of the State. Furthermore, access to a suitably licensed driver to supervise learner drivers in remote areas also proves problematic.

In 2009, the DoT introduced Remote Areas Licensing Program (RALP). Through the experience and success of RALP, DoT has seen the benefits of taking licensing services 'to the people' through an outreach service. Although still in its infancy, this model has seen a renewed focus on licensing in remote areas with many previously uninterested or ineligible applicants progressing to obtaining a learner's permit or provisional driver's license. In 2012, the DoT is seeking to build on the success of RALP by implementing outreach program. The Program will establish regular licensing services to remote Aboriginal communities in the West and East Kimberley, the Pilbara, and the Goldfields, which is a multi-faceted approach to addressing licensing issues within the remote areas of Western Australia.

The WA Equal Opportunity Commissioner recently approved this program for inclusion in the 2012 CEO Substantive Equality Summary, as an example of a best practice Substantive Equality in action.

Funding has now been approved and the program will be formally deployed over the next six to twelve months. It is planned to undertake an initial evaluation of the program during this time and submit this as a formal case study for a future report.

Victorian State Government

The Victorian Government recently established two strategic advisory committees: the Better Services Implementation Taskforce (BSIT) and, the Victorian Information, Communication and Technologies Advisory Committee (VICTAC). The broad-based industry membership on both Committees has been formed so that government can take advantage of the innovations and lessons learned in other large enterprises, and from the ICT and services industry itself.

The Committee's first tasks are to develop new government service and technology strategies, which bring substantial benefits for citizens and the Victorian ICT industry, as well as for government itself. Strategies are due to be released for broader consultation toward the end of 2012.

The Victorian Government continues to leverage innovative social communications, tools and platforms to develop and provide a rich and diverse range of digital services, easily found at www.vic.gov.au/social-media.html and including recent releases:

MyShopRights app – provides instant advice on refund, warranty and lay-by rights:
www.consumer.vic.gov.au/shopping/myshoprights-app

FireReady apps – real time bushfire information:
www.cfa.vic.gov.au/warnings-and-incidents/cfa-on-your-mobile.htm

The Victorian Government data directory and top-level sites are being redeveloped and are scheduled for release in September and October 2012, respectively.

Local Government Case Studies:

For information about all 27 category winners and the overall national award winners, in the National Awards for local Government 2012, go to www.regional.gov.au/local/awards/ [Accessed 28 May 2012]

For information about the Innovation in Local Government: Defining the Challenge, Making the Change Supplement to the ACELG Better Practice Guide which contains12 local and international local government better practice case studies go to www.acelg.org.au/news-detail.php?id=226 [Accessed 28 May 2012]

CHAPTER 7

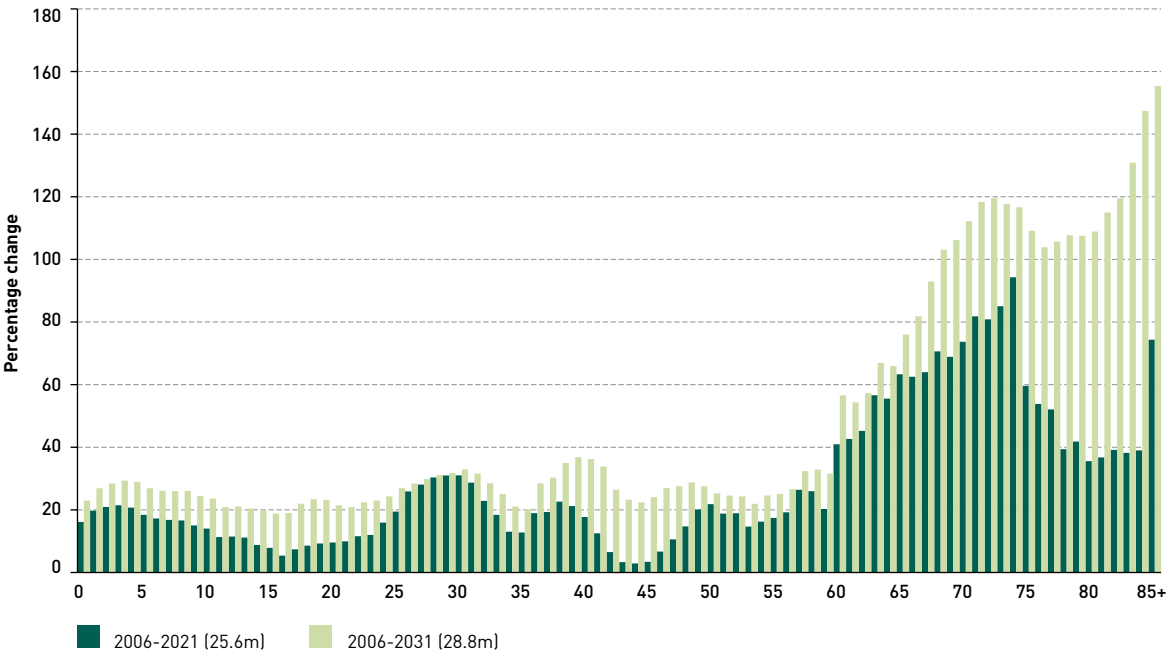
Innovation opportunities for Australia's future

This chapter discusses the emerging opportunities, challenges, and trends for the Australian innovation system. It provides examples of where productivity improvements may be achieved through policy and industry innovations that address the changing social, environmental and economic aspects of both contemporary Australia and its place in the world.

Australia's ageing population: Emerging issues and challenges for the national innovation system

The majority of OECD countries are characterised by ageing populations with low population growth rates, while the demography of the developing world is broadly characterised by youthful rapidly growing populations. Chart 7.1 shows projections for Australia's age structure.

Chart 7.1: Structural ageing, Australia: percentage change by age, 2006-2021, 2006-2031



Source: ABS (2008) *Population Projections, Australia, 2006 to 2101*, cat. no. 3222.0

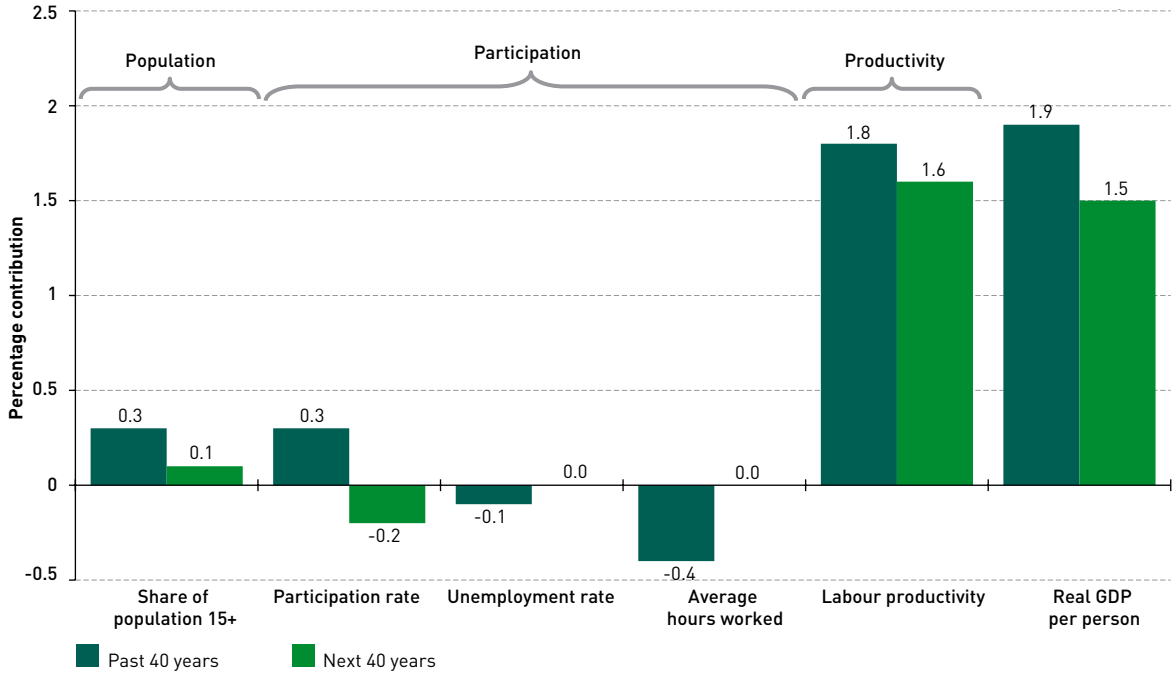
Baby boomers make up 28% of the Australian population and 42% of the labour force. In 2011, this cohort began passing the 65-year threshold and people are beginning to leave the workforce in significant numbers. Chart 7.1 also reveals that there is a hollowing in the age pyramid between the ages 5 and 18 with fewer children (under 15 years of age) in the population. Hence, the numbers entering the workforce will decline over the next decade before the recent increase in fertility will see the numbers begin to increase again.[202]

202 Hugo G. et al (2010) Demographic change and liveability panel report, in DSEWPaC (2010) *A Sustainable Population Strategy for Australia,* Issues paper and appendices, pp.38-39.

This age distribution will impact on national productivity, the way we produce our goods and services, and the way in which our education, training and migration programs address these challenges. Increased rates of innovation creation and/or adoption of innovations will be vital across many areas of the economy and society to support an ageing population, both in the workplace, in post work life and in the care of our ageing population. This will involve a wide range of social, workforce and technological innovations coordinated between governments and industry.

The Intergenerational Report recognised that in order to counteract the effect of the shift in the age structure, interventions in the three 'Ps' – population, participation and productivity, is required. Chart 7.2 suggests that enhancing productivity per person has the greatest potential to counterbalance the deteriorating balance between working age and older populations. The section below outlines some of the opportunities and the role of innovation in an ageing population.

Chart 7.2: The three Ps of growth in real GDP per person



Source: Australian Government (2010) *Australia to 2050: future challenges*, Intergenerational Report 2010, Treasury, Canberra, xiii.

Innovation opportunities in an ageing population

Healthcare

The scale of the ageing population, not just in Australia but across many countries, is likely to transform all markets where older people participate or demand services and goods. This will be met by a parallel, but not necessarily equal, supply response from businesses.

Where governments have a role, they will also be influential in shaping markets, labour, goods, insurance and health, to name just a few, to better serve a more aged society.[203] The scope for innovation in the supply of services to this growing demographic will be enormous, not least in the field of health.

New global developments in health business models, notably in biopharmaceuticals, augur significant benefits for older people who tend to have greater health concerns as they age. The future of health services, it is argued, may be a connected health environment based on transparency of big data and care that is

203 DIISRTE released the report *Enabling Technology Futures: A Survey of the Australian Technology Landscape* in November 2012. The report provides a view of the future of nanotechnology, biotechnology and synthetic biology, including areas of convergence. It provides insights into emerging applications that are informing future strategies, products, markets and investment opportunities. These three types of enabling technologies have been selected as they are considered fundamental to R&D across a wide number of areas, including manufacturing, energy production and agriculture.

personalized and consumer-directed.[204] In matching the right treatment to the right patient at the right time, waste may be dramatically reduced and health outcomes improved.

Technological innovation will be the essential driver of these market reforms. Using diagnostic technology and big-data mining, it will be possible to better identify a patient sub-population, such as aged people at risk of dementia. Social media and new portable devices will enable improved monitoring of patients and, importantly, by patients themselves, so that more specific and effective care can be delivered. As noted in the 2011 Australian Innovation System report, the National Broadband Network (NBN) will provide a platform for a wide range of innovative and more accessible e-Health services using new/smart technologies. CSIRO is playing a significant role in improving healthcare services throughout Australia - for example, by building on CSIRO technologies, it will be possible to deliver:[205]

- improved home-based care systems;
- an intelligent portal for medical image analysis; and
- improved access to medical data.

Just as important to the reformed delivery of health services to the aged, will be the education of health professionals, gerontologists, aged carers and their adoption of new, more productive ways of delivering care utilising e-Health technologies. Nay *et al.* caution, however, that there are long lead times to effectively realise major changes in professional training.[206] For example, it will take at least 10 years to bring about major change as educational institutions will also need to incorporate industry expectations into curricula.

In addition to developing the skills needed to apply innovative approaches to aged care, research into various aspects of ageing can show better and more effective ways of improving the well-being of the aged. Two notable initiatives in Australia in this regard are detailed below.

The Australian Imaging, Biomarker & Lifestyle Flagship Study of Ageing (AIBL), a project seeking to discover which biomarkers, cognitive characteristics, and health and lifestyle factors determine subsequent development of symptomatic Alzheimer's Disease (AD).[207]

The PATH Through Life project at the ANU's Centre for Research on Ageing, Health and Well-being, a 20 year longitudinal cohort study of people at different ages as they move through life encountering various health risks with a focus on psychological processes and resources that affect health outcomes and influence positive ageing and adaptation. PATH aims to track and define the lifespan course of these health risks, identify environmental risk and protective factors associated with them, and examine the relationships between illnesses such as depression, anxiety and substance use with cognitive ability and dementia.[208] The Centre's social gerontology stream researches how social relationships, psychological resources and personality characteristics are related to health, well-being and cognition in older adulthood. A particular focus is on late life transitions (e.g. retirement, widowhood, residential relocation, and driving cessation) and how psycho-social characteristics of groups and individuals might affect adaptation.[209]

Case study of a novel health care delivery model

Use of technology for achieving superior healthcare delivery has been advocated for decades. One of the key obstacles in the wide scale application of technological solutions in the healthcare space has been the difficulty in the assimilation of new technologies into the whole healthcare delivery process as well as the ramifications and implications to other systems already in place.

One novel approach being trialled is a diabetes monitoring device (DiaMonD). Described as a pervasive wireless technology solution, it is designed to provide superior healthcare for sufferers of diabetes. The solution incorporates software that facilitates the ubiquitous monitoring of an individual's diabetes, thereby contributing to diabetes self-management. It is grounded in trying to support key components of a chronic disease care model.

The web-based model (INET) provides the necessary components to enable the delivery framework to be positioned in the best possible manner so it can facilitate enacting the key components of the chronic disease model successfully (Table 7.1).

204 Marwaha S, Milch B & Savas S (2012) *Biopharma in the coming era of 'connected health'*, McKinsey & Co.

205 http://www.csiro.au/Outcomes/ICT-and-Services/healthcare-revolution-through-ehealth-innovation.aspx [Accessed 9 August 2012].

206 Nay R, Katz B, Le Couteur D, Murray M (2009) Innovative responses to a changing health care environment, in Nay R & Garrett S (Eds) *Older People: Issues and Innovations in Care,* Elsevier, Chatswood, p.414

207 www.aibl.csiro.au [Accessed 20 September 2012].

208 http://crahw.anu.edu.au/research/projects/personality-total-health-path-through-life [Accessed 20 September 2012]

209 http://crahw.anu.edu.au/research/groups/social-gerontology [Accessed 20 September 2012].

The INET model focuses on enabling and supporting all areas necessary for the actualization of ICT initiatives in healthcare. It identifies the inputs necessary to bring an innovative chronic disease management solution to market. These solutions are developed and implemented through a physician-led mobile e-health project. The DiaMonD monitoring device, through the INET model, delivers a relatively low cost solution to diabetes monitoring which empowers the patient through enhancing self management.

The process steps in monitoring diabetes using the DiaMonD approach are outlined below:

- Each patient receives a blood glucose measurement unit.
- Patient conducts the blood glucose test and enters the blood glucose information into a hand-held wireless device.
- The blood glucose information is transmitted to specialised database servers that store patient data. Patient's hand-held device uniquely identifies the patient for recording the blood glucose data. Thus no patient information such as the name, ethnicity or date of birth is transmitted to the clinic.
- The patient's blood glucose data is then stored and integrated with the clinic's electronic medical record system.
- An alert is generated for the clinical staff with the patient's blood glucose information.
- The blood glucose information of the patient is reviewed by the clinical staff (physician/nurse).
- Feedback on glucose levels is transmitted back to the patient's hand-held device. Feedback examples include complimenting the patient when glucose levels are normal, or asking the patient to come for a follow-up appointment when the levels are out of norm.
- Monitor trends in diabetes management for patients over a period of time.

Table 7.1: Components of the chronic disease model and the corresponding INET solutions

Component	Description	How addressed in INET Model
Organization of Health System	› Leadership in chronic disease management (CDM) › Goals for CDM › Improvement strategy for CDM › Incentives and regulations for CDM › Benefits	Key inputs from the specific healthcare system are incorporated primarily into the People, Process, Platform and Protection components.
Self-management support	› Assessment and documentation of needs and activities › Addressing concerns of patients › Effective behaviour change interventions	Key inputs from the specific healthcare system are incorporated primarily into the People, Process, Platform and Protection components.
Decision Support System	› Evidence-based guidelines › Involvement of specialists in improving primary care › Providing education for CDM › Informing patients about guidelines	Key inputs from the specific healthcare system are incorporated primarily into the People, Process and Platform components.
Delivery System Design	› Practice team functioning › Practice team leadership › Appointment system › Follow-up › Planned visits for CDM › Continuity of Care	Key inputs from the specific healthcare system are incorporated primarily into the People, Process and Platform components.
Clinical Information Systems	› Registry › Reminders to providers › Feedback › Information about relevant subgroups of patients needing services › Patient treatment plans	Key inputs from the specific healthcare system are incorporated primarily into the People, Process and Platform components.
Community	› Linkages for patients to resources › Partnerships with community organizations › Policy and plan development	Key inputs from the specific healthcare system are incorporated primarily into the People and Process components.

The ageing agricultural workforce

The ageing of the agricultural workforce poses major challenges to the agrifood sector of feeding Australia's population as well as contributing to that of a global population of 9 billion by 2050. Australia has an enviable level of food security, producing over 89% of our domestic food supply and exporting 80% of total gross value. Meeting the skill and labour needs of the industry is critical to future national and global food security, sustainable industry development, and ensuring robust communities in regional Australia.

The agrifood industry is made up of 180,000 mostly small to medium sized enterprises and a workforce of more than 880,000 people, with 57% based in regional Australia covering the entire food supply chain. It makes a significant contribution to the national economy, generating more than $200 billion each year and accounting for around 20% of Australia's export earnings.[210]

The agrifood industry is facing significant challenges to secure labour supply due to a rapid ageing of the workforce, low unemployment rates in regional Australia, and a movement of labour to other industries such as mining. The age profile of the workforce is a critical labour supply constraint for the rural sector. By 2018, 38% (of a 2008 workforce of 305,763 in agriculture) will be over the age of 65 years. The scale of both high skilled para-professionals and professionals and lower skilled labour shortages, due to a rapidly ageing workforce, will accelerate in severity both in the near future and in the longer term.[211] This will pose significant threats to future industry productivity and sustainability.[212]

The Australian Government and industry are working together to find solutions to these serious challenges. In 2008, the Government announced the Pacific Seasonal Worker Pilot Scheme (PSWPS) to address seasonal labour shortages in the horticulture industry and contribute to economic development in the Pacific through providing employment opportunities for five demographically youthful Pacific Island Countries (PICS).[213]

Due to strong productivity outcomes and development benefits, from 1 July 1 2012 the pilot scheme became a permanent scheme, the *Seasonal Worker Program,* and will be expanded to the cotton, sugarcane and seafood industries. From this date, the program was expanded from Kiribati, Papua New Guinea, Tonga, Vanuatu to include citizens of Nauru, Samoa, Solomon Islands, Tuvalu and East Timor. In a survey of the horticulture industry, Hays and Howes noted 'the generally very positive experience of the small number of growers who have actually participated in PSWPS,'[214] despite the additional 10% in recruitment and regulatory costs of using PICS workers.[215] Grower satisfaction is generally based on the reliability of the workers and an increase of 30% additional productivity on using alternative labour sources. Similar productivity gains were found to occur under the similar *Recognised Seasonal Employer* scheme in New Zealand.

Outcomes of a recent Senate inquiry[216] into the higher skills needs of the industry will add further impetus for increased policy coordination and innovation between government and industry such as illustrated in the above example, to address the deepening of the labour supply crisis.

CSIRO megatrends

Public and private sector investors in the Australian innovation system are keen to ensure each dollar spent yields the maximum possible return. This requires investors to continually ask on what and where should they spend their money. It's a challenging question. What problems should we be solving today via science, research and technology investments to ensure our children and grandchildren enjoy a better life?

In 2009, CSIRO commenced a global foresight study to inform internal long range investment planning decisions. The aim was to examine future trends to help ensure every dollar was spent on the research, science and technology solutions of most benefit to the Australian people. The work was well received internally and formed an important part of the organisation's broad direction setting process.

210 AgriFood Skills Australia (2011) *Environmental Scan 2011.* AgriFood Skills Australia, Barton, ACT.

211 *Ibid.*

212 Senate Education, Employment and Workplace Relations Committee (2012) *Higher education and skills training to support agriculture and agribusiness in Australia,* Commonwealth of Australia, June.

213 Ball R (2010) Australia's Pacific Seasonal Worker Pilot Scheme and its interface with the Australian horticulture labour market: Is it time to refine the policy? *Pacific Economic Bulletin* 25: 114-130; Ball R, Beacroft L & Lindley J (2011) Australia's Pacific Seasonal Worker Pilot Scheme: managing vulnerabilities to exploitation, *Trends & Issues in Crime and Criminal Justice* 432: 1-8.

214 Hay D & Howes S (2012) *Australia's Pacific Seasonal Worker Pilot Scheme: Why has take up been so low?* Development Policy Centre Discussion Paper 17.

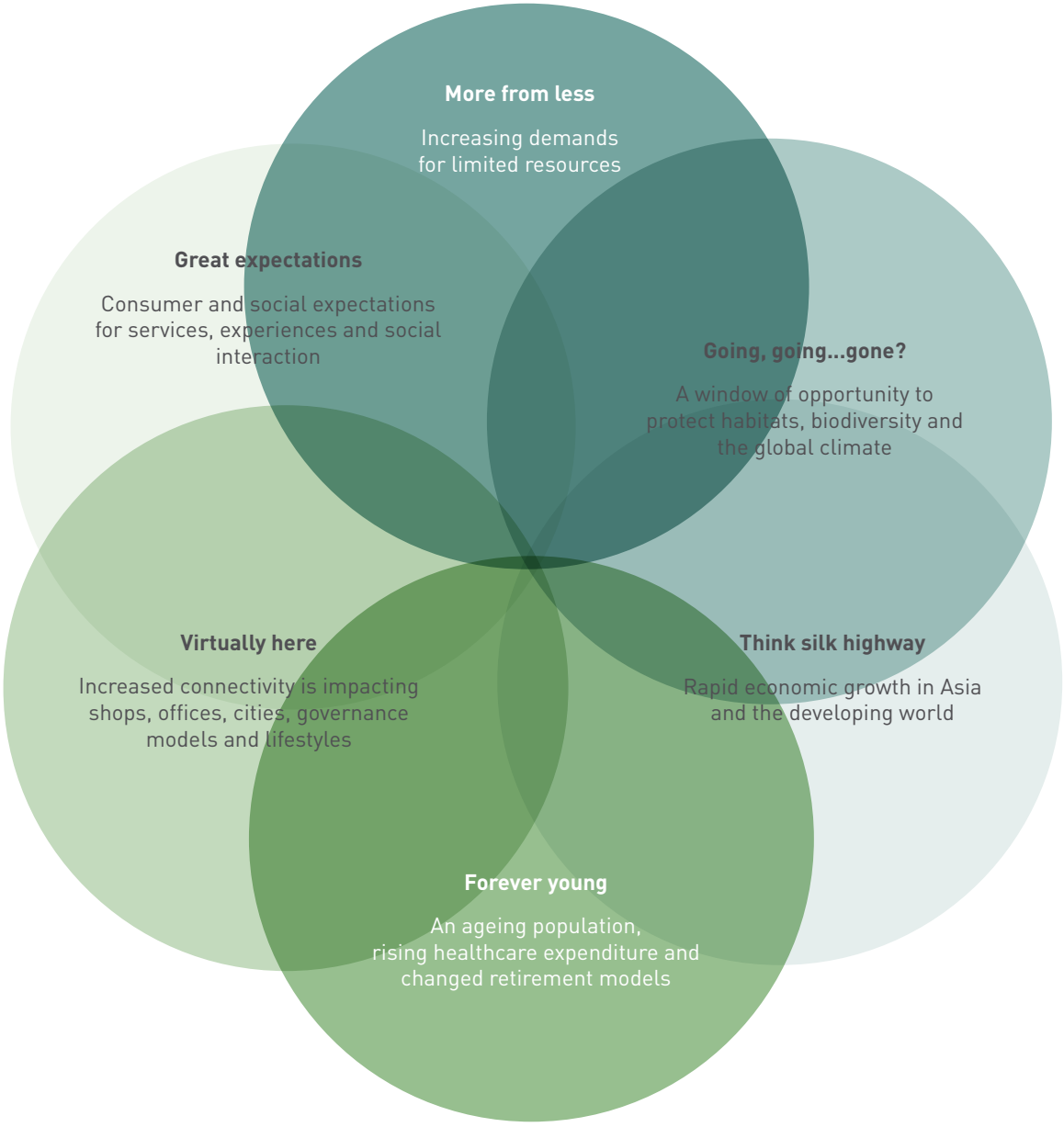
215 Bedford R (2012); Halloran C (2012) "Australia's Pacific Worker Pilot Scheme: Working against the odds." Development Policy Blog, 24 May.

216 Senate Education, Employment and Workplace Relations Committee (2012) *Higher education and skills training to support Agriculture and Agribusiness in Australia,* Commonwealth of Australia, June.

The revised CSIRO megatrends

The CSIRO Futures team released the second version of *Our Future World* on 5 September 2012.[217] This captures feedback on the original work from hundreds of industry experts, scientists, government staff and community members over a two year period.

The narrative of the future presented in *Our Future World* consists of six interlinked megatrends. A megatrend is a significant shift in environmental, economic and social conditions that will play out over the coming decades. The indicative time frame for the analysis is 20 years. The megatrends are presented as an interlinked Venn diagram and each megatrend is described in more detail below along with a brief snapshot of CSIRO research activities aligned with each megatrend.



1. More from less. The Earth has limited supplies of natural minerals, energy, water and food resources essential for human survival and maintaining lifestyles. Data are revealing many of these resources are being depleted at often alarming rates. At the same time population growth and economic growth are placing upward pressure on demand. The *More from less* megatrend explores how companies, governments and communities will discover new ways of ensuring quality of life for current and future generations within the

217 http://www.csiro.au/en/Portals/Partner/Futures/Our-Future-World-report.aspx [Accessed 20 September 2012].

confines of the natural world's limited resources. Science, technology, business processes, government policy, lifestyle patterns and cultural norms will all play a role.

Food security is one of the challenges stemming from the *More from less* megatrend. Research to achieve a more food secure world is occurring under CSIRO's Sustainable Agriculture Flagship and Food Futures flagships.

Agricultural land is disappearing at alarming rates due to degradation processes whilst at the same time food demand is rising. In addition, agriculture presents challenges and opportunities for mitigating climate change. Agriculture also has a role to play in energy security through biofuel production. Agriculture lies at the nexus of many of the world's most challenging dilemmas.

CSIRO is partnering with many private and public sector organisations to tackle the challenge of food security from a number of angles. In Australia, CSIRO is working with farmers to find ways of boosting crop and pasture productivity whilst maintaining and improving environmental standards. This includes research into more efficient farming systems involving precision agriculture, developing plants that tolerate acidity and salinity and decision making tools for grazing land management.

Overseas, CSIRO is working with governments, companies and communities to build improved food security through identifying enhanced production systems and improved institutional arrangements. This includes work designed to better link farmers to markets in South Africa, innovative use of forage legumes in Indonesia and increasing wheat productivity in Bangladesh.

Food security is but one of the many challenges connected to the *More from less* megatrend. CSIRO is also finding solutions via developing ways to process mineral ores more efficiently, manage energy supply and demand more efficiently and mitigate water scarcity. This research is occurring under the Minerals Down Under Flagship, the Water for a Healthy Country Flagship and the Energy Transformed Flagship. All these flagships contain research which is finding innovative ways to get more from less and build a more sustainable future.

2. Going, going, ...gone? Many of the world's natural habitats, plant species and animal species are in decline or at risk of extinction. The actions taken by human beings in the coming decades will set the scene for global biodiversity over coming millennia. The *Going, going ...gone?* megatrend explores the perilous situation of the world's ecological habitats and biodiversity. This megatrend also captures the issue of greenhouse gas emissions and climate change. Much in the natural world, that humans value and depend upon, is at risk of being lost forever. However, there is a positive story and a potentially bright future. The megatrend is purposefully posed as a question. Whilst the state of biodiversity is in decline and the pressure is rising so too is the human response.

CSIRO has a depth of expertise in fields such as ecology, biology, conservation planning and environmental economics. Many scientists in these areas are working on ways to protect valuable habitats and to conserve endangered species.

One angle involves maintaining a record of Australia's biodiversity through the national science collections. This includes the Australian Wildlife Collection, National Herbarium Collection, National Insect Collection and National Fish Collection. These collections are maintained by CSIRO and provide a critical record of our plant and animal species. The data is being assembled into an Atlas of Living Australia, which is described as the 'biodiversity yellow pages'.

Another approach involves the use of decision techniques to better target conservation efforts. The extent of Australia's vulnerable habitats is huge compared to the resources we have for repair and maintenance. This makes targeting crucial. In the Kimberly region of northern Australia, CSIRO ecologists have worked with land managers to identify and target restoration of the habitat of the charismatic Gouldian Finch – a native bird species under threat in light of habitat loss.

Yet another angle being pursued by CSIRO involves the use of economics to design market based instruments for efficient and effective protection of biodiversity assets. One example comes from the design of conservation auctions. These instruments involve bids from farmers to provide conservation services. They create new markets and allow for efficient protection of ecological assets. The CSIRO researchers working in this area have helped design auction systems in New South Wales and Queensland.

3. The silk highway. Coming decades will see the world economy shift from west to east and north to south. Rapid income growth in Asia and, to a lesser extent, South America and Africa will see billions of people transition out of poverty and into the middle income classes. The powerhouses of the new world economy are China and India. This economic shift will build new export markets, trade relations, business models

and cultural ties for Australia. Tourists, funds and ideas will increasingly flow out of Asian countries and into Australia's economy and society. We are stepping into an Asian Century.

CSIRO is increasingly working in the Asian region via numerous science initiatives. A recent meeting called the "East Asia Summit" involved policy-makers from 18 Asian countries meeting with counterparts from the Australian Government and CSIRO in Makassar Indonesia from 17-19 April 2012. The workshop explored common themes of urban water sustainability and livelihoods under a changing climate.

CSIRO is also working with partners in Asian countries to help improve agricultural land management practices. In Cambodia and Laos, CSIRO is investigating irrigation systems based on groundwater for lowland rice cropping in the Svay Rieng and the Savannakhet Province.

In Bangladesh and India, CSIRO researchers are using field trials and modelling systems to make improved predictions of crop production in light of climate, crop variety, soil type and management factors. This research is helping these countries build sustainable food production systems that will support future economic growth.

In August 2012, a delegation of senior CSIRO scientists visited China to share ideas and celebrate 35 years of collaboration between CSIRO and China. During this exchange it was noted that this year, for the first time ever, investment in science, research and technology in the Asian region surpassed the Americas. The ties between CSIRO, China and the Asian region are likely to strengthen and deepen over coming decades.

4. Forever young. The ageing population is an asset. Australia and many other countries that make up the OECD have an ageing population. Elderly citizens provide a wealth of skills, knowledge, wisdom and mentorship. Nevertheless, there are some challenges associated with an ageing population and associated demographic trends. Two of these challenges include Australia's widening retirement savings gap and rapidly escalating healthcare expenditure. This will change people's lifestyles, the services they demand and the structure and function of the labour market.

Demographic forecasts by the Australian Bureau of Statistics reveal the extent of the challenge. When the ageing population is combined with longer life expectancy we identify an additional challenge: the retirement savings gap. This is the shortfall in savings for the current workforce to have a 'comfortable' retirement. An estimate of Australia's retirement savings gap by Rice Warner Actuaries puts the figure at A$836 billion as of 30 June 2011 (A$79,200 per person).[218]

These pressures might redefine the concept of retirement into the future. A study of public sector employees in Australia finds that both men and women would prefer to maintain a form of reduced employment in retirement rather than cease work altogether[219]. There is a body of research relating to tapered retirement models which may help this transition. One such model is the Retirement Transition Adjustment Framework[220] that builds upon the Minnesota Theory of Work Adjustment[221].

Whilst there may be more aged people in the workforce than before they can struggle more to find a job than younger people. The Australian Bureau of Statistics (ABS, 2011b) reports that one third (33%) of unemployed persons aged 55-64 years, and actively seeking work, were out of a job for at least one year and considered long term unemployed. This compares with 22% of those aged 35–44 and 13% of those aged 15–24 years.[222]

The ageing population is a key driver of growing healthcare expenditure. Health spending is projected to grow from 4% of GDP in 2009–10 to 7% of GDP in 2049–50. [223] Over the medium term there is growth in spending on all areas of healthcare: hospitals, medical benefits, pharmaceuticals and private health insurance.

The *Forever young* megatrend has profound implications for service delivery systems, labour markets, retirement models and the healthcare sector. New and innovative ways of doing business are essential to maximise the benefits of this megatrend and minimise the risks. CSIRO research is addressing the *Forever young* megatrend from many angles. Research is occurring in the medical and pharmaceutical field, manufacturing, human services and information technology. Countless innovations are being developed to treat and prevent age related illnesses and to help ensure a good quality of life for older generations.

218 Rice Warner Actuaries (2011) *Retirement Savings Gap at June 2011*, report for the Financial Services Council, Sydney http://www.fsc.org.au/downloads/file/ResearchReportsFile/FINAL_FSCSuperannuationSavingsGapReport2011.pdf [Accessed 2 November 2012].

219 Onyx J & Baker E (2006) Retirement expectations: gender differences and partner effects in an Australian employer-funded sample. *Australian Journal on Ageing* 25: 80-83.

220 Hesketh B, Griffin B, & Loh V (2011) A future-oriented retirement transition adjustment framework. *Journal of Vocational Behaviour* 79: 303-314.

221 Dawis RV (2005) The Minnesota theory of work adjustment. In *Career Development and Counseling: Putting Theory and Research to Work* (Eds. Brown SD & Lent RW), John Wiley and Sons, pp. 3–23.

222 ABS (2011) *Australian Demographic Statistics*, cat. no. 3101.0.

223 Australian Government (2010) *Australia to 2050: future challenges*, *op. cit*.

One of the pharmaceutical areas being investigated relates to ASPREE (ASPirin in Reducing Events in the Elderly). This research involves a double-blind placebo controlled prevention trial examining whether regular use of low dose aspirin delays the onset of chronic illness disorders. These disorders include cancers, vascular disease, and dementia.

Forever young looks at the rising issue of lifestyle related chronic illnesses. One way of tackling this challenge is improving the quality of foods we eat. BARLEYmax™ has been in development by CSIRO for the past 12 years and is the world's highest fibre wholegrain. It is being used in Australian breakfast cereals.

By delivering double the fibre content and four times the level of resistant starch than normal wholegrain BARLEYmax™ improves bowel function and digestive health. Further research is being conducted into other enhanced whole grains such wheat and rice.

Another approach involves improving the diets of children. Childhood obesity rates are too high and are a major challenge before Australia's healthcare system and society.

The CSIRO well-being plan for children published by Penguin Australia provides practical advice to parents about achieving the right nutrition in diets and sufficient physical activity. Lifestyle adjustments represent a cost-effective means by which to improve health outcomes given the rise of chronic illnesses.

In addition to these efforts, CSIRO is working with Monash University to explore a possible superannuation research alliance. This is yet to come into being, but has much potential. It could involve research into retirement savings strategies and retirement models that harness the economic contribution of an elderly demographic.

5. Virtually here. This megatrend explores what might happen in a world of increased connectivity where individuals, communities, governments and businesses are immersed into the virtual world to a much greater extent than ever before. We are increasingly moving online to connect, to deliver and access services, to obtain information and to perform transactions such as shopping and working. Online retail and teleworking in Australia are forecast to grow rapidly with impacts on labour markets, retail models, city design and transportation systems. Digital media is allowing people to form new connections and selectively access information through multiple channels with subsequent erosion of trust in traditional information sources. The digitally connected world is virtually here.

The rise of social media is creating new opportunities for the provision of human services by government, industry and community organisations. For example, under the Human Services Delivery Research Alliance (a five year research program jointly funded by CSIRO and the Australian Government Department of Human Services, which encompasses Medicare and Centrelink), CSIRO researchers are developing a software tool called 'Vizie'.

The Vizie software uses technologies for automated text analysis to search multiple social media platforms for mention of particular government services (*e.g.* Centrelink services). The software can detect the difference between an incidental reference to a service versus those cases where the service is the focus of the online conversation. This allows the software to identify "hot topics" that allow the service delivery agency to make targeted communications about the types of services available and where, when and how customers can access them.

6. Great expectations. This is a consumer, societal, demographic and cultural megatrend. It explores the rising demand for experiences over products and the rising importance of social relationships. This megatrend also captures the expectation people have for personalised services that meet their unique needs and wants whilst being delivered en masse. This megatrend has implications for the Australian retail sector and human service delivery systems of government and private sector organisations. People of the future will have expectations for more personalised, better, and faster services. They will seek higher-end experiences due to income growth and the over-supply of mass consumables. Social relationships will hold increased importance given the potential for social media and digital communication burnout and the desire for face-to-face interaction. Conversely, for the billions of impoverished people in the world the expectations are still for the basic necessities of life such as water, food, clothing, shelter and personal security. Many will have great expectations, but many will still have basic expectations.

Under the Human Services Delivery Research Alliance, CSIRO worked with the Australian Government Department of Human Services (including Medicare and Centrelink) to develop decision support tools and metrics to target human services. Many service delivery systems have a transactional focus. This research aimed to explore ways of moving beyond transactional measures to design outcome metrics relating to human well-being. If developed through future research these metrics could encompass outcomes such as employment, health and social connections.

In other research, CSIRO is developing technologies that help people tailor their diets and physical activities to achieve the maximum possible health benefit. This is occurring through the Preventative Health Flagship. A software tool called a 'tailoring engine' allows users to capture information about what they have been eating and how they have been exercising. This can be matched to a person's unique physiological characteristics to identify the optimal diet and exercise options. The weight mentor management system is based on the CSIRO diet book. It was developed in partnership with Tasmanian company, Verdant Health. This technology is an example of personalised medicine.

Conclusions

The ageing of the Australian population provides significant challenges to Australia's future. It also provides opportunities to develop a range of social, workforce, and industry research and technological innovations for domestic and international markets.

CSIRO's foresight work identifies and anticipates key issues and contributes a strategic policy focus that provides the impetus for national scenario planning around the key issues faced by Australia and our national innovation system into the future.

The case studies discussed under the innovation opportunities above canvass some of the variety of ways that innovation can meet the challenges and opportunities that lie ahead. Innovation in social and international engagement can meet the needs of an industry facing labour shortages to the great benefit of Australian industry, and for the development outcomes of our Pacific neighbours with rapidly growing population.

Similarly, the research bridging the digital age and the health needs of an ageing population have significant potential to not only to help provide health care for people in their homes, in regional and remote Australia, but to also allow people to engage in the workforce for longer and more productively due to innovation in health monitoring and catering to individual needs.

Innovation is key to productivity in an ageing Australia. The big opportunities and challenges ahead will be met through a diversity of innovation strategies and the development of new industries, which will address not only Australian demand, but also that of other ageing OECD countries.

APPENDIX 1

A summary of innovation policy developments across Australia

This section is an overview of the online companion volume accompanying this report, the *Compendium of program updates*, which can be found at www.innovation.gov.au/AISreport2012/program_compendium.

New programs and policy updates for 2012

This compendium is an outline of new or significant developments in government initiatives that foster innovation. It has been compiled based on updates received from various government departments and agencies for the *Australian Innovation System Report 2012*. It includes more than two hundred initiatives or activities. The Australian Government share of these initiatives in terms of numbers is around 40%.

This compendium is not a comprehensive overview of all government initiatives that support innovation. For a more complete view, the reader is encouraged to visit the Australian Government's www.business.gov.au; www.arc.gov.au and www.grantslink.gov.au websites.

In 2009, in *Powering Ideas; an Innovation Agenda for the 21st Century*, the Australian Government committed itself to a ten-year horizon with the objective to build a stronger national innovation system. This undertaking involved the setting of seven national priorities on improving skills and expanding research capacity; increasing innovation in business, government and the community sector; and boosting domestic and international collaboration for the purpose of innovation and the on the production, diffusion and application of new knowledge.

The National Innovation Priorities were to complement Australia's National Research Priorities, which were focused on public sector research. For six of the seven National Innovation Priorities, specific targets were set and progress against these targets has been reported in each of the successive Australian Innovation System Reports.

To make progress towards achieving these targets, the Australian Government has implemented a number of programs and initiatives. State and Territory Governments also implement a number of innovation focused initiatives and programs. Many of these are complementary to those delivered by the Australian Government and there are significant efforts to maintain a high level of coordination both within the Australian Government, through the *Coordinating Committee on Innovation*, and across governments, through the *Commonwealth, State and Territory Advisory Council on Innovation*. While Australian Government programs have a national focus, the programs of the state and territory governments respond more to regional issues. As the large number of new programs and policy updates suggest, there is a considerable level of activity in the area of government support for innovation. Areas of common activity include supporting innovation through:

- Business management and other skills development;
- Health and health related issues and services;
- Environmental issues such as clean technology;
- Technology and trade;
- Partnerships and collaborations; and
- Network and precinct creation and building.

Government programs aim to facilitate access to seed finance; provide incentives for direct business investment in R&D and innovation; support workforce development; and develop fairer, more productive and innovative workplaces. Governments are also helping businesses become more capable and self sufficient including through providing support for businesses and individuals to build capability through innovation, science, skills acquisition, research and collaboration.

THE AUSTRALIAN GOVERNMENT'S NATIONAL INNOVATION PRIORITIES (ANNOUNCED IN *POWERING IDEAS* IN MAY 2009)

Priority 1: Public research funding supports high-quality research that addresses national challenges and opens up new opportunities.
Target: The Australian Government's ambition is to increase the number of research groups performing at world-class levels, as measured by international performance benchmarks.

Priority 2: Australia has a strong base of skilled researchers to support the national research effort in both the public and private sectors.
Target: The Australian Government's objective is to significantly increase the number of students completing higher degrees by research over the next decade.

Priority 3: The innovation system fosters industries of the future, securing value from the commercialisation of Australian research and development.
Target: The Australian Government aims to see a continuing increase in the number of businesses investing in R&D.

Priority 4: More effective dissemination of new technologies, processes, and ideas increases innovation across the economy, with a particular focus on small and medium-sized enterprises.
Target: The Australian Government's goal is to achieve a 25 per cent increase in the proportion of businesses engaging in innovation over the next decade.

Priority 5: The innovation system encourages a culture of collaboration within the research sector and between researchers and industry.
Target: The Australian Government's ambition is to double the level of collaboration between Australian businesses, universities and publicly-funded research agencies over the next decade.

Priority 6: Australian researchers and businesses are involved in more international collaborations on research and development.
Target: The Australian Government has adopted the long-term aim of increasing international collaboration in research by Australian universities.

Priority 7: The public and community sectors work with others in the innovation system to improve policy development and service delivery.

Research and skills

There are significant numbers of government research, skills development and education policies and programs across Australia. Areas of research seem to be quite diverse ranging from space, biotechnology and health, to resources. The focus of these policies tends to be funding research infrastructure and/or funding quality research activities. Skills and capability development is being promoted using a range of technologies, as well as the development of structured learning frameworks and programs to fill critical skills gaps at a national, regional or sectoral level. In addition governments across Australia have created research institutions and skills development bodies that are themselves innovating.

The Australian Nuclear Science and Technology Organisation (ANSTO) has been developing new nuclear, biomedical and environmental technologies. Its new National Imaging Facility (NIF) Research Cyclotron for biomedical imaging, which was opened in December 2011, enables scientists and medical practitioners to better see inside the body in search for causes of diseases. ANSTO also commercialised its ground breaking water cleansing technology in early 2012. The technology was sold to the Australian clean-tech company, BioGill Environmental Pty Ltd. The technology has numerous industrial and environmental applications, including the treatment of grey water, sewage and wastewater for aquaculture, and food and beverage processing.

The *Research Workforce Strategy* provides a framework for the Government to meet Australia's research workforce challenges. The strategy covers the decade to 2020, considering the key challenges and opportunities for Australia's research workforce. The overarching objective of the strategy is to develop a strong and productive research workforce to support the Government's innovation agenda. The implementation of the strategy over the next decade will involve collaboration between governments, universities and other research training providers and public and private researcher employers.

The Australian Government's *Industry Innovation Councils* contributed to the design, delivery and accreditation of skills for management, the workforce and students. For example, the *Information Technology (IT) Council* collaborated with the Australian Curriculum, Assessment and Reporting Authority on the development of a national curriculum for ICT. The Council has also contributed to the development of the *Research Workforce Strategy* and more recently to the Australian Workforce Productivity Agency's *Australia's skills & workforce development needs* discussion paper. The Council stressed the importance of recognising changing skills needs in a digital economy. The *IT Council* also supported the development of a national framework providing global accreditation for Australian ICT trained professionals who undertake planned and structured professional development through accredited courses which was led by the Australian Computer Society. The majority of these councils are winding up at the end of 2012.

The *Joint Research Engagement (JRE) Grant – Engineering Cadetships* is a new element within the existing JRE scheme which enables participating higher education institutions to support the research training costs associated with higher degree by research students undertaking a cadetship in areas of engineering or science. Cadetships will involve a combination of formal research training (research doctorate or research masters) with the institution and concurrent employment by a business to carry out R&D activities. The JRE Grant - Engineering Cadetship scheme will run from 2012 to 2015 with the Australian Government providing funds from within the JRE scheme over this period.

The *Australian Space Research Program* (ASRP) is a government initiative with the objective to develop Australia's niche space capabilities by supporting space-related research, innovation and skills in areas of national significance or excellence. The ASRP funding supports collaborative space research and innovation projects, on the one hand, and student projects and educational activities, on the other.

Skills for All is a South Australian Government initiative for vocational education and training. The program objectives are to: raise the skills level of South Australians; increase the number of South Australians with post school qualifications; and increase labour force participation. Fundamental to this initiative will be a renewed partnership with industry with a strong commitment to maximising investment in workforce training.

Another initiative is the joint investment by Defence South Australia and the University of Adelaide to construct a new facility in the University of Adelaide's world-leading Institute for Photonics and Advanced Sensing (IPAS). The facility which is due for completion by early 2013 will house a unique suite of trans-disciplinary laboratories which will boost science teaching and research.

Business innovation

The Australian Government manages many of the framework conditions required to facilitate business innovation, including an appropriate taxation system, financial system, labour relations, and market competition and openness. The business regulatory environment is distributed across governments as it often requires a more granular approach.

There are also many government initiatives that directly support or encourage business innovation across Australia. Technologies are being used to assist in the delivery of business services through portals and utilising emerging technologies, and aligning with the deployment of the National Broadband Network (NBN). Governments provide a diverse range of grants and services to businesses in an attempt to foster a culture of innovation, build innovation capacity in businesses, fund innovation activities or encourage investment in innovation by third parties.

The R&D Tax Incentive is the largest program supporting the government's goal of lifting the number of innovating and R&D-performing businesses and opened for registration on 1 July 2012. It provides an incentive to address market failures connected with undertaking R&D. The incentive provides financial support to encourage Australian companies to undertake additional R&D activities. This will deliver wider benefits to the economy and society.

New and emerging technology applications are also underpinning initiatives such as space research, biotechnology developments and the more effective use of ICT. National ICT Australia (NICTA), as Australia's information and communications technology Centre of Excellence, is a major Australian Government investment in Australia's ICT capabilities. NICTA continues to foster business innovation in the field of ICT. Since its inception, NICTA has enabled the establishment of numerous spin-out companies. In May 2011, its new spin-out company *Nitero* received funding from Commercialisation Australia to take its 60GHz gigabit wireless technology to the market. In May 2012, NICTA announced the official launch of *Scalify*, a new Melbourne-based start-up company specialising in peer-to-peer networking technology. NICTA also leads a number of industry clusters, such as the e-Government cluster with both government and industry

representation. Through the e-Government cluster, NICTA is organising a conference in which SMEs will have the opportunity to market their innovations to government.

Many initiatives have a specific industry sector focus. *Digital Futures Strategy*, for example, is an initiative of Tasmanian Government aligned to the Tasmanian NBN roll-out. The *Digital Futures Strategy*, which runs from 2012 to 2015, is part of the *Tasmanian Science Strategy*, and is designed to leverage the NBN to create an innovative, sustainable and vibrant Tasmanian Digital Economy.

Another example is the *Entrepreneur Development Fund*, a pilot program funded by the ACT Government. Having commenced in July 2011, the *Entrepreneur Development Fund* will run until 31 December 2012. The program is designed to contribute to the costs of skills and knowledge transfer to high-growth potential businesses in the ACT. It is intended to supplement existing ACT and Australian Government grants in facilitating skills and knowledge transfer to potentially high-growth SMEs in the ACT.

Links and collaboration

As research and innovation becomes more complex and costly, it is requiring ever more diverse knowledge inputs. But increased specialisation can lead to reduced diversity of knowledge within businesses and other organisations, requiring them to look outside their boundaries for expertise. These collaborative partnerships and ventures are taking place at the local, cross-jurisdictional and international levels. So, governments in Australia recognise the significant scope and need for industry to benefit from the research expertise of government agencies and universities through linkage and collaboration. Many government programs have been specifically designed to encourage research-industry collaboration.

For example, the Australian Government will invest $236 million over five years, through Australian Research Council's new Industrial Transformation Research Program, to foster collaborative research between businesses and universities in such areas as engineering, materials science and nanotechnology, communications, chemical engineering and biotechnology. The program will also support PhD students and researchers to gain practical skills and experience in these areas.

The CSIRO is administering a program designed to foster collaboration through Precincts. The CSIRO Precincts are designed to enable researchers to collaborate across organisational boundaries by co-locating their expertise and creating talent pools with the capacity to resolve complex challenges. These CSIRO Precincts seek to create multiplier benefits by both attracting researchers and furthering collaborations. CSIRO is also engaged in setting up Global Precincts to expand and deepen Australia's global partnerships involving universities, government agencies and industries. The objective of Global Precincts is to help unleash Australia's innovation potential, improve Australia's international R&D competitiveness, and position Australia's innovation system to address world's emerging complex challenges.

The National Health and Medical Research Council has launched a partnership initiative consisting of two types of award: Partnership Projects and Partnership Centres. The initiative aims to bring teams of researchers and policy and practice decision-makers together to create better health services. The National Health and Medical Research Council has also partnered with the California Institute for Regenerative Medicine in a collaborative research grants scheme.

Many state and territory governments have recently adopted innovation voucher programs to encourage cross-sector collaboration. The Queensland, NSW, Victorian and Western Australian governments have all adopted or trialled vouchers for areas of regional specialisation. The program generally encourages collaboration between SMEs and other organisations. The Western Australian Government's Innovation Vouchers Program, launched in November 2011, seeks to assist SMEs to overcome some of the barriers that exist on the path to commercialisation. Under the program, eligible Western Australian-based SMEs have access to up to $20,000 that can be used towards engaging professional skills or services that will help businesses take an idea to a commercial reality.

Public sector and social innovation

It is imperative for the public sector to be innovative in the development of policy and the delivery of services that ultimately provide better quality of life for the community. There is a strong theme throughout many of the initiatives, both Australian Government, and State and Territory governments, on environmental, social or public sector innovation. These include improvements in government service delivery, indigenous education, health and culture, and human and/or animal health (such as vaccine production and Hendra virus research).

An example of government programs for social innovation is the new initiative by CSIRO and the Department of Human Services (DHS) to form a research alliance to improve the government service delivery to millions of

Australians. The objective of the Human Services Delivery Research Alliance (HSDRA) is to harness the power of innovative technology and practice to dramatically improve the flexibility and effectiveness of the Human Services portfolio (including Centrelink, Medicare and the Child Support Agency) in delivering services to the Australian community.

Another example is a new initiative by Australian Research Council (ARC) under its *Special Research Initiatives* scheme. The initiative involves the establishment of an Aboriginal and Torres Strait Islander Researchers' Network (ATSIRN), a national network which will bring together Aboriginal and Torres Strait Islander researchers from across Australia, from different research institutions, at different career stages and from a range of disciplines. ATSIRN will be led by experienced Indigenous Australian researchers, who will build research programs and mentor research students and early career researchers working on research that generates understanding about Indigenous knowledge and culture.

State governments have also made moves towards public service innovation. The Victorian Government, for example, has launched an initiative for public service innovation comprising establishment of two strategic advisory committees with a broad-based industry membership to develop strategies that would ensure the government would learn from the innovations in large commercial enterprises. Strategies are due to be released for broader consultation toward the end of 2012. The Western Australian Government has also launched an initiative for public service innovation. The WA Public Sector Innovation Working Group was formed at the request of the State's Executive Coordinating Committee to prepare the WA Public Sector Innovation Action Plan. It includes representatives from a number of state government agencies, such as the Departments of Commerce, Department of Transport, Public Sector Commission and Indigenous Affairs.