Chapter 2

Why is innovation important?

Innovation-active businesses in Australia account for a disproportionate share of economic activity. They contribute to over 60 per cent of sales and employment, and they are 40 per cent more likely to increase income and profitability, compared to other businesses. The positive impacts of innovation on performance get stronger the more regularly businesses innovate. Overall business expenditure on innovation was between $26 and $30 billion in 2014–15, and the income from sales of innovative goods and services alone was around $60 billion in the same year.

Decades of economic research demonstrate that innovation is a key driver of competitiveness and growth for both businesses and societies.[12] We have introduced new indicators and new analysis that show a significant causal impact of innovation on business performance. All else being equal, the impact of innovation on business growth is significant and positive, and this effect gets stronger as businesses innovate more regularly. High-growth businesses drive the majority of employment, sales, exports and economic growth in Australia. In particular, start-up businesses that are less than three years old make a disproportionate contribution to growth on every indicator examined.

Consistent with the literature, this chapter introduces new indicators and new analysis to provide compelling evidence of the impact of innovation on Australian society.

2.1 Innovation is a key factor for competitiveness

Innovation is a key factor for competitiveness and growth in developed economies like Australia's.[13] The OECD estimates that as much as 50 per cent of economic growth in its member countries can be accounted for by innovation activity, and that this contribution will grow.[14] Innovation has been demonstrated to drive productivity growth and the competitive advantage of businesses.[15]

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

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

A healthy innovation system is therefore vital to Australia if we are to maintain and improve our economic position in the face of increasing global competition, climate change and an ageing workforce.

Just as effective innovation can be a source of competitive advantage to a business, a high-performing innovation system can deliver competitive advantage to the Australian economy.[16] Research shows that in competitive markets, innovative businesses out-compete other businesses by achieving higher rates of business survival and growth in employment and profits.[17] Uncompetitive businesses fail and their resources are reallocated to these more productive and profitable business, resulting in allocative efficiency and increasing aggregate productivity growth across the economy.[18] Businesses with exposure to international competition have more than double the rate of productivity growth, better management quality, and greater and more novel innovation than their domestic counterparts.[19]

2.2 Measuring the outcomes of the innovation system

One way to indirectly measure the performance of the innovation system is to review how Australia performs on broad outcome indicators. Economic, health, employment, social inclusion, social equity and environmental sustainability outcomes (Appendix Tables A1 and A2) will in part reflect past performance of the innovation system, and identify areas requiring further development.

There has been a steady increase in Australia's real GDP. Australia is currently ranked 12th of 36 OECD+[(c)] countries for the index of GDP per capita relative to the USA. Australia's score dropped in 2015 for the second consecutive year since its highest level in 2013.

Australia's GDP per capita was previously assisted by the boom in commodity markets. The commodity boom resulted in favourable terms of trade, so the recent decline can be correlated with the decreasing demand and lower prices for Australia's resources. In the wake of the mining boom, productivity gains have been weak.

[(b)] Depending on the elasticity of demand.

[(c)] OECD+ includes all countries in the OECD, as well as China, Taiwan and Singapore (where data is available).

Australia is currently ranked last of 35 OECD+ countries on economic complexity.[20] Given the relationship between market diversification and innovation presented in Sections 2.5 and 3.2, this may reflect the fact that Australia is a resource rich country and a significant share of its exports is made up of commodities.[(d)]

GDP per hour worked is above the OECD+ average, but well behind the OECD+ top five country average. Only the Australian mining sector appears to have productivity levels above the OECD average and amongst leading businesses worldwide. This is consistent with a high R&D intensity and revealed technological advantage in that sector.[21]

The OECD has found that productivity growth at the global frontier has remained relatively robust in the 21st century, despite the slowdown in average productivity growth for most OECD countries. For example, labour productivity at the global frontier (the global top 100 most productive businesses) increased at an average annual rate of 3.5 per cent in the manufacturing sector over the 2000s, compared to an average growth in labour productivity of just 0.5 per cent for non-frontier businesses. This gap is even greater in the services sector. The OECD has raised concerns that this rising gap in productivity growth between the global frontier and other businesses represents:

- a poor ability of the most advanced businesses nationally to adopt new technologies and knowledge developed at the global frontier
- limited diffusion of existing technologies and knowledge from national frontier businesses to laggards
- a rise of tacit knowledge as a source of competitive advantage for global frontier businesses.[22]

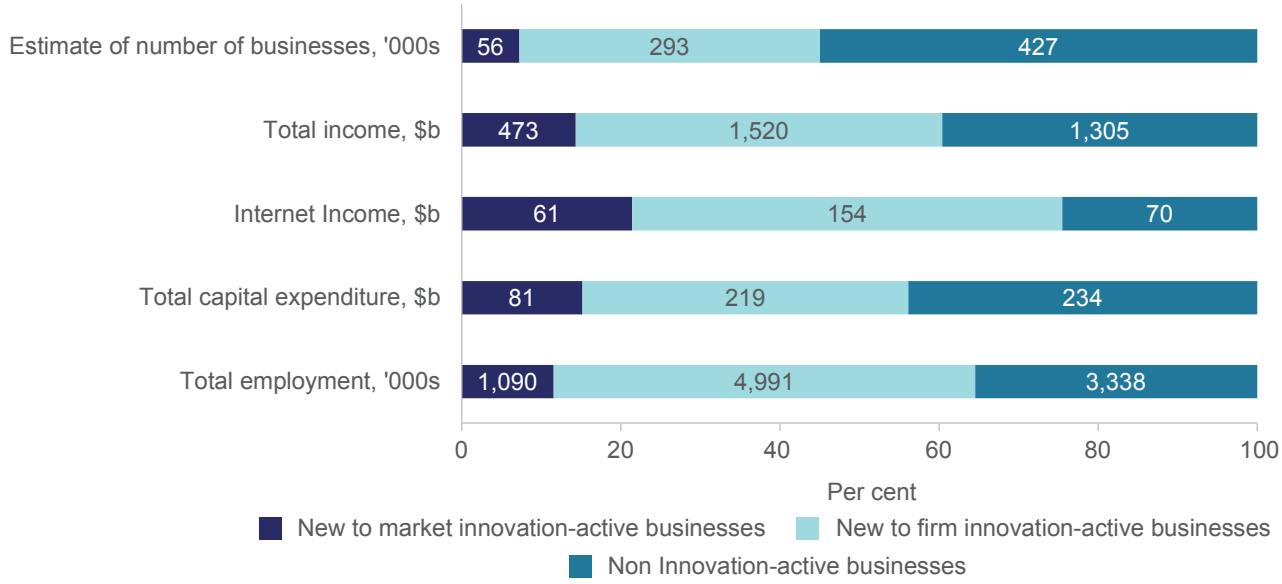
2.3 The economic contribution of innovative businesses

Another way of looking at the contribution of innovative businesses to the economy is to estimate whether their share of total economic activity is more than you would expect from their total share of all businesses.

Figure 2.1 illustrates the disproportionate share of the Australian economy's total income, net income and employment held by innovation-active businesses. Although innovation-active businesses were only 45 per cent of all businesses in 2014–15, they accounted for over 60 per cent of sales and employment. Businesses introducing new-to-market innovation (Chapter 3) have an even greater disproportionate share of sales and employment (up to three times what one would expect from their share of businesses). These findings reinforce international studies that show that innovative businesses can disproportionately drive job creation and income growth.[23]

[(d)] See Chapter 3 for a detailed discussion of new to market innovation.

Figure 2.1: Total estimated number of employing businesses that are innovation-active, and their contribution to employment, income and capital expenditure, 2014–15



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

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

2.4 The economic contribution of high-growth businesses

High-growth businesses are a small fraction of total businesses in an economy, yet generate most of the jobs and sales turnover. They are most likely to be young, most likely to be innovative, and are found across all sectors of the economy. Most international studies also indicate that these businesses seldom remain high-growth businesses, to the extent that the emergence of high-growth businesses is often likened to a random process, meaning high-growth businesses cannot be identified ex ante.[24]

Earlier analysis undertaken by the OCE shows that, compared with their low- and medium-growth counterparts, Australian high employment growth micro start-ups exhibit superior financial performance, higher innovation activity (particularly operational process and organisational/managerial innovation) and a greater demand for external equity finance.[25]

From a management perspective, medium and high employment growth start-ups were also significantly more likely to monitor and assess their performance across a wider range of performance indicators. These data are consistent with other evidence that suggests that sustained innovation and high growth comes from superior strategic management.[26]

Definition 2.1: OECD relative measures of growth

High-growth businesses are businesses with average annualised growth in sales or employment greater than 20 per cent a year over a three-year period.

Gazelles form a subset of high-growth businesses that have been employers for a period of up to five years.

Medium-growth businesses are businesses with average annualised growth in sales or employment between 10 and 20 per cent a year over a three-year period.

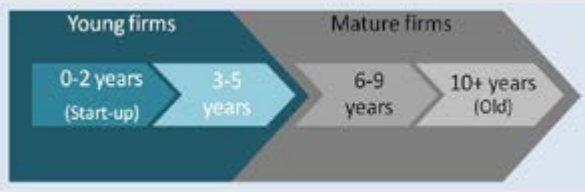
Low-growth businesses are businesses with average annualised growth in sales or employment between 1 and 10 per cent a year over a three-year period.

Nil- or **negative-growth businesses** are businesses with average annualised growth in sales or employment equal to or less than zero per cent a year over a three-year period.

Definition 2.2: Business age classes

We adopt the business age class definitions set out by the OECD. Young businesses are defined as businesses aged between zero and five years of age. Start-ups are a specific subset of young businesses within the first three years of operation (0–2 years old).

Mature businesses are defined as those businesses aged six years and older. Old businesses are a specific subset of mature businesses that are ten or more years old.



Using the BLADE and relative definitions of sales growth and age (Definitions 2.1 and 2.2), we were able to show that, unsurprisingly, high sales growth businesses make a disproportionate contribution to growth in Australia (Figures 2.2 and 2.3; Methodology 2.1). Over the seven-year period from 2004–05 to 2010–11 there were over 800,000 new jobs created, total sales grew by $1.4 trillion, export sales grew by $0.22 trillion, and $0.44 trillion of value was added to the economy. High sales growth businesses generated the majority of this growth, accounting for 66 per cent of net positive employment, 67 per cent of net positive sales, 84 per cent of net positive export and 70 per cent of net positive economic growth. High sales growth businesses accounted for around 30 per cent of all businesses in Australia. The results are similar when using employment as the growth indicator.

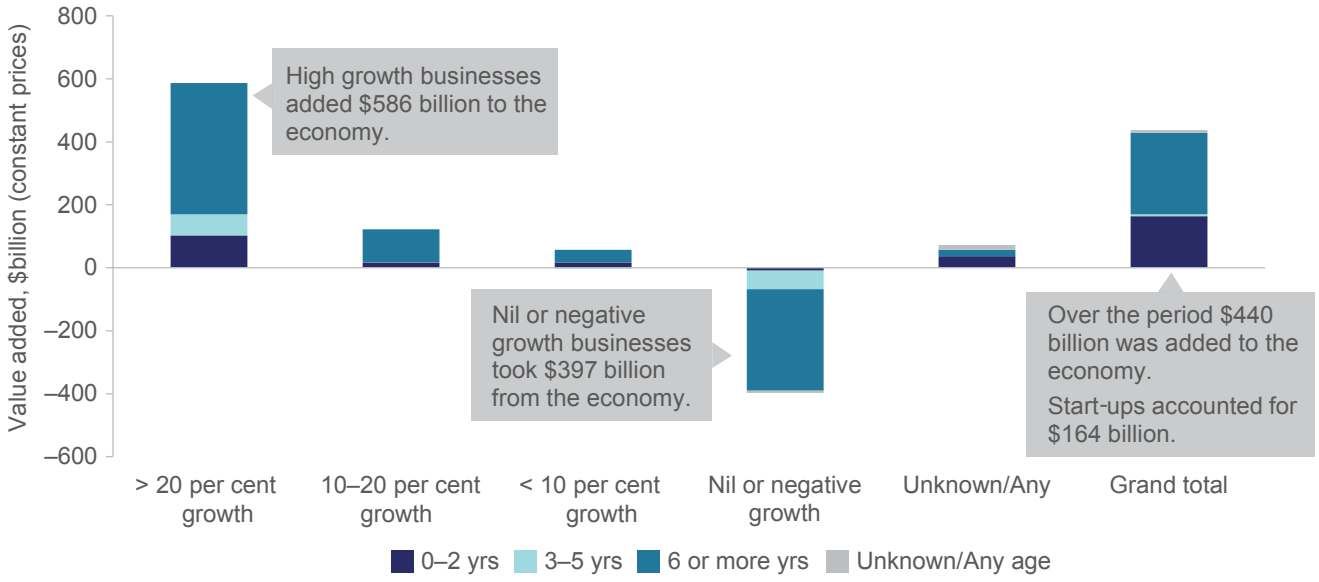
Start-ups and growth

Figure 2.3 shows that start-ups (0-2 years) are the largest contributor to job creation, accounting for 1.2 million new jobs over the period 2004–05 to 2010–11. This represented 90 per cent of net positive job creation. The contribution of start-ups is not directly comparable with the number stated in the 2015 report. The latest analysis includes an additional financial year and data from financial corporations was excluded based on advice from the ABS. While start-ups accounted for the majority of net job creation, their net contribution to sales, exports and economic growth is not as great as mature businesses. Our latest research finds that over the seven-year period, high sales growth start-ups generated the majority of start-ups jobs (780 000 out of 1.2 million jobs). In addition, high sales growth start-ups created $360 billion in sales, $100 billion in value added and $15 billion in exports over the same period.

Although the absolute impact of start-ups might be lower, they make a disproportionate contribution to growth in all indicators observed in Figure 2.4 start-ups make a high economy-wide contribution to net employment creation. This is because they tend to add more than they subtract overall, but also more than double what one would expect from their share of total employment (Figure 2.4). As businesses age they make a lower contribution to growth in every indicator examined, such that by the time they are six or more years old they contribute less than their total aggregate share (of the relevant indicator).

While the results show that start-ups contribute disproportionately to employment creation in Australia, mature medium and large businesses are still significant net contributors to sales and value-added growth, and are the major net contributors to export growth. With the exception of employment, mature small businesses tend to generate net losses in the Australian economy. This is why the cumulative effect of mature businesses can often appear as a net negative (Figure 2.3).

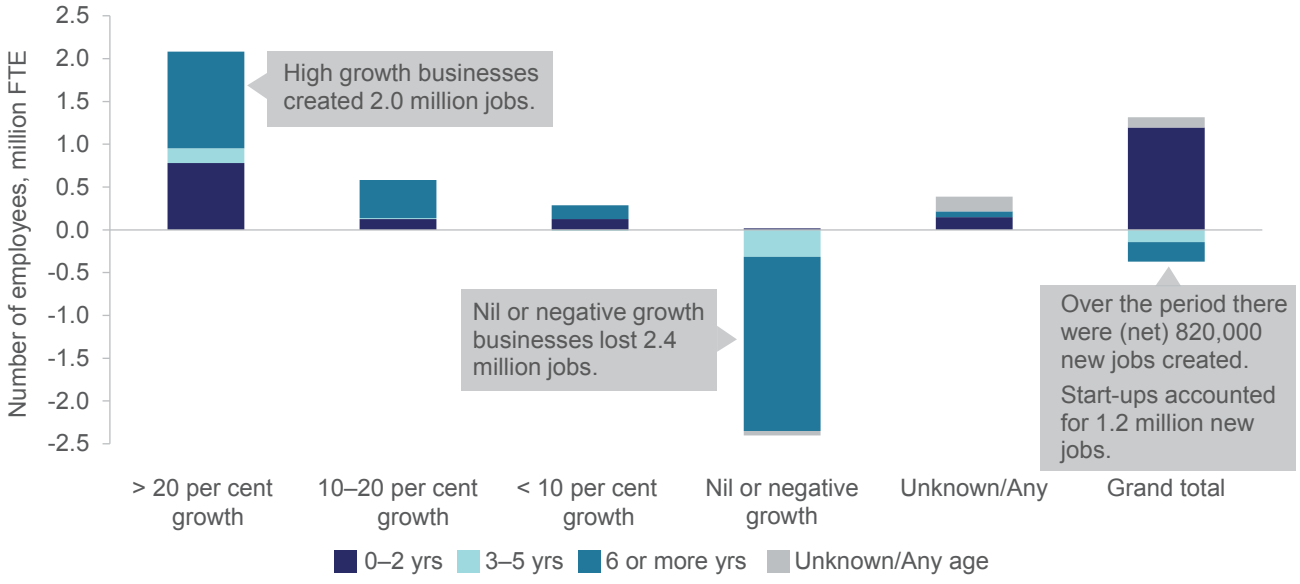
Figure 2.2: The net contribution of businesses to economic growth, by business age and average annualised growth class, 2004–05 to 2010–11



Notes: Averages incorporate all industry classes except Standard Institutional Sector Classification of Australia 2 (SISCA2) businesses. Average annualised growth rates are calculated on a total sales basis over a rolling three-year period.[21]

Source: ABS (2016) Business Longitudinal Analysis Data Environment. Customised data report commissioned by the Department of Industry, Innovation and Science

Figure 2.3: The net contribution of businesses to employment growth, by business age and average annualised growth class, 2004–05 to 2010–11



Notes: Averages incorporate all industry classes except SISCA2 businesses. Average annualised growth rates are calculated on a total employment basis over a rolling three-year period.

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

Methodology 2.1: Calculating the contribution of businesses to national aggregates

We use the ABS' BLADE to calculate the contribution of businesses of different ages, sizes and growth classes to aggregate growth in total sales, export sales, employment, labour productivity and value added.

We use total sales growth as the basis for defining the growth classes. The three-year annualised growth rate and business age definition restricts the length of the period we can analyse to 2004–05 to 2010–11. We have done similar work using a one-year growth rate and found similar results over the longer period 2002–03 to 2013–14.

Growth ranges for the first year of a unit's existence are calculated based on their rate of change for sales and/or full-time equivalent (FTE) employees in their first consecutive year.

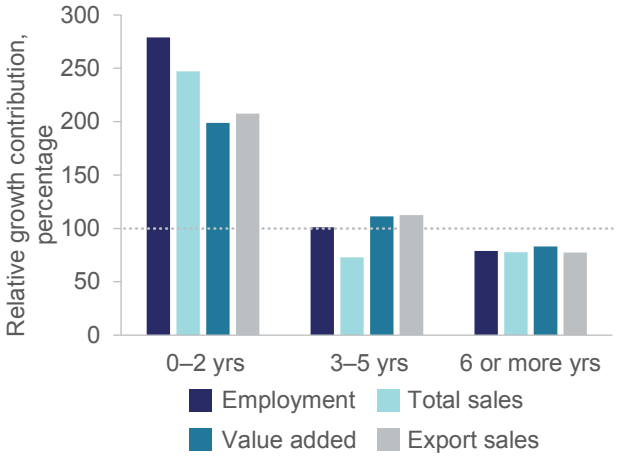
SISCA2 businesses (Finance & Insurance sector) and a handful of businesses with extreme and unlikely values have been excluded.

Value Added has been calculated as: Sales income (BAS Turnover less GST payable) minus Intermediate Usage (BAS Other (i.e. current expenses) less GST credits). Capital expenses and wages/salaries are not part of VA calculation. Labour productivity is the ratio of Value Added per full-time equivalent (FTE) employee.

Businesses contribute where they are classified each cycle, so a business can contribute to different age, size and growth classes over time.

Firms that exit during the period are included in the results where their growth could be determined.

Figure 2.4: Contribution of businesses of different ages to growth relative to their share of employment, total sales, export sales or value added in Australia, 2004–05 to 2010–11



Notes: Averages incorporate all industry classes except SISCA2 businesses. Relative growth contribution is calculated as the percentage contribution to total aggregate growth (e.g. employment) divided by that sector's total share of employment (i.e. relative to 100 per cent).

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

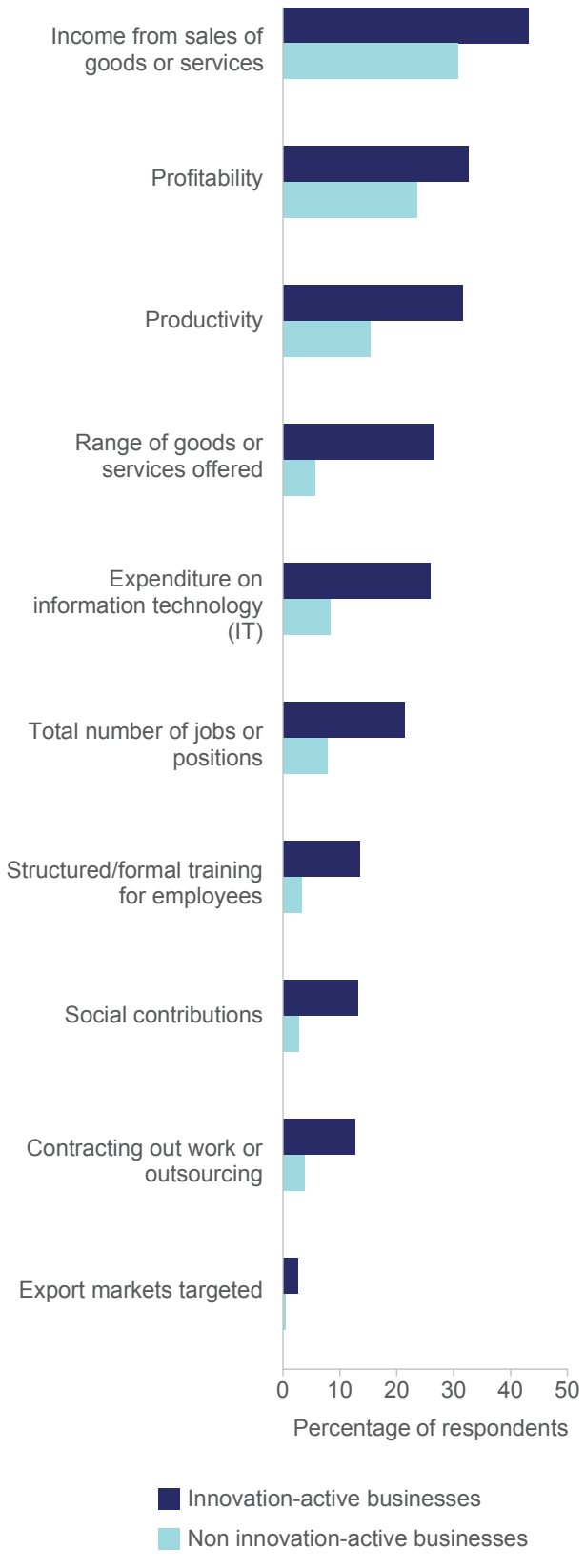
2.5 The benefits of innovation

The link between innovation and broader business performance in Australia is demonstrated in Figure 2.5. The data shows that in 2014–15, innovation was significantly correlated with higher business productivity growth, employment growth, market diversification and a range of other performance outcomes.[28] These results are consistent across all industry sectors and over time.[29] Compared with businesses that don't innovate, innovation-active Australian businesses are:

- 40 per cent more likely to increase income and profitability.
- twice as likely to export, and five times more likely to increase the number of export markets targeted.
- two to three times more likely to report increased productivity, employment and training.
- three times more likely to increase investment in IT.
- almost five times more likely to increase the range of goods and services offered, and make social contributions such as donations.

These results are consistent with research that demonstrates a positive relationship between innovation, competitiveness and, in particular, exporting and productivity growth.[30] Recent research shows that salary, employment and productivity benefits can persist for years after an innovation is introduced.[31]

Figure 2.5: Increases in business performance and activities compared to the previous year, by innovation status, 2014–15



Source: ABS (2016) *Selected characteristics of Australian business, 2014–15*, cat. no. 8167.0

2.6 The relationship between innovation and firm growth

A common criticism of measures of the impact of innovation is the problem of causation. Since there are numerous ways in which a business could gain competitive advantage, a strong correlation between business performance and innovation may simply reflect some other aspects of the business that do not relate to innovation. Moreover, the results presented in Figure 2.5 rely on self-reported data collected in the BCS, which can suffer from a selection bias.

To address these issues, we worked with the ABS to develop a new metric to measure the impact of innovation on business performance in a more reliable fashion (Methodology 2.2). Figure 2.6 shows a significant positive association between innovation and business performance. In particular, we show that businesses that persistently innovate (see Definition 2.3) significantly outgrow other businesses in sales, value added, employment and profit.

New analysis using BLADE shows that the frequency of innovation matters, as the positive impact of innovation gets stronger when businesses innovate more frequently. Persistent innovators significantly outgrow other businesses in terms of sales, value added, employment and profit growth. The data shows that between the period 2008–09 and 2010–11, persistent innovators generated:

- 18 times the value added growth of intermittent innovators
- four times the employment growth of regular innovators
- five times the sales growth of regular innovators.

We applied a propensity score matching model and regression to BLADE data to simulate a randomised controlled experiment. The results show that the relationship between innovation and business growth is significant, positive and direct (Table 2.1). Regressions using innovation persistence group dummy variables show positive and significant coefficients for gross output growth and value-added growth (data not shown).

By addressing causal uncertainty over the three year period in the study, we show a strong modelling evidence of a causal relationship between innovation and business performance.

Definition 2.3: Innovation persistence

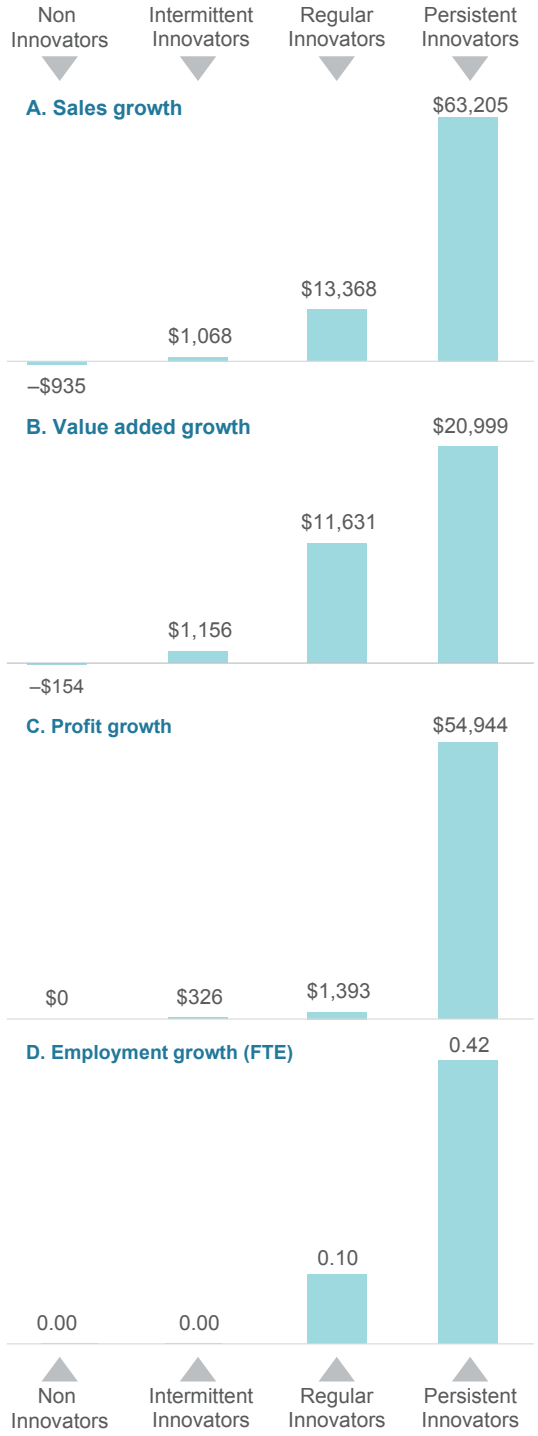
'Persistent innovators' are businesses that reported introducing any innovation every year over a three-year period.

'Regular innovators' are businesses that reported introducing any innovation in two years out of a three-year period.

'Intermittent innovators' are businesses that reported introducing any innovation in one year out of a three-year period.

'Non-innovators' are businesses that did not report introducing any innovation within a three- year period.

Figure 2.6: Median growth of annual sales (panel A), value added (panel B), gross operating profit (panel C) and employment growth (panel D), by innovation persistence, 2008–09 to 2010–11



Notes: This chart includes both simple and complex firms, and therefore differs from Table 2.1. They also report on different time periods. Analysis of Variance shows a significant effect of innovation persistence on these four growth indicators ($p<0.05$) for both SMEs and large firms.

Source: ABS (2016) Business Longitudinal Analysis Data Environment. Customised data report commissioned by the Department of Industry, Innovation and Science

Methodology 2.2: Measuring the impact of innovation persistence

In this study we examined the performance of Australian businesses that reported persistence of innovation over the three-year period, 2011–12 to 2013–14.

We generated a balanced panel sample distribution of 6,000 businesses from the BLADE. We determined the impact of the persistence of innovation on 2013 outcomes, using business characteristics from 2011 as covariates and non-innovators as the control group. We looked at simple business (where these have simple structures and a single ABN) and complex business (large, diverse and complex structure) models.

We investigated the causal relationship between business innovation and performance using propensity score matching (kernel method). This technique is designed to minimise selection bias by matching each innovating business with a non-innovating business that has the same or similar observed characteristics. This has the effect of minimising the effect of other characteristics that might influence a business's performance. We controlled for business age, size, sector, information and communication technology (ICT) intensity, collaboration, competition, foreign ownership, government assistance, flexible working arrangements, skills base, skills shortages, export status and debt or equity finance seeking behaviour.

Histogram and kernel density of propensity scores mapping show that the distribution of propensity scores becomes more similar between the treated and control groups after matching. Plots reveal a clear overlapping of the distributions. This is consistent across all models used. There is also a large reduction in bias.

Regressions using persistence group dummy variables for gross output and value added were carried out to confirm the presence of cumulative effects from innovation persistence.

Table 2.1: Average treatment effect on treatment differences between simple-structured innovators and non-innovators (control), by innovation persistence, 2010–11 to 2012–13.

Outcomes	*Persistent innovators*	*Regular innovators*	*Intermittent innovators*
Value Added output ($)	**1 440 056	628 687	738 327
Gross Output (Business income tax) ($)	***2 689 158	***3 278 584	**1 988 192
Turnover ($)	***3 951 768	**2 804 453	**2 521 148
Gross output growth (2011–2013) ($)	***1 807 495	382 008	107 598
FTE (numbers)	***14	5	**11
Total salaries & wages ($)	**376 375	**312 009	*489 113
Export sales ($)	*323 118	87 164	161 867
Value added growth (2011–2013) ($)	*860 695	-458 367	-215 256
Treated observations[(a)]	849	806	835
Total observations[(a)]	**1994**	**1951**	**1980**

Notes: Values are the difference from the non-innovator control group. Analysis of simple structured businesses using a derived balanced panel. * p<0.1; ** p<0.05; *** p<0.01; (a) Sample size for most outcome variables except productivity and growth where there are missing values.

Source: ABS (2016) Business Longitudinal Analysis Data Environment. Customised data report commissioned by the Department of Industry, Innovation and Science

2.7 A new indicator for the impact of innovation

One of the criticisms of Figure 2.5 is that it is based on a survey of respondent's opinions of their own business's performance. To address this response, we collaborated with the ABS and the University of Tasmania to introduce an Australian-first method for measuring the impact of innovation on the economy (Methodology 2.3; Feature article in Chapter 1).

The total proportion of innovation-active businesses in Australia earning a quarter or more of their income from innovative[(e)] goods and services was 16 per cent in 2014–15. As businesses increase in size, the proportion of income earned from innovative goods and services declines significantly (Figure 2.7).

In 2014–15 the total proportion of businesses in Australia earning a quarter or more of their income from innovative goods and services were:

- 21 per cent for micro-sized businesses
- 11 per cent for small-sized businesses
- 11 per cent for medium-sized businesses
- 3 per cent for large-sized businesses

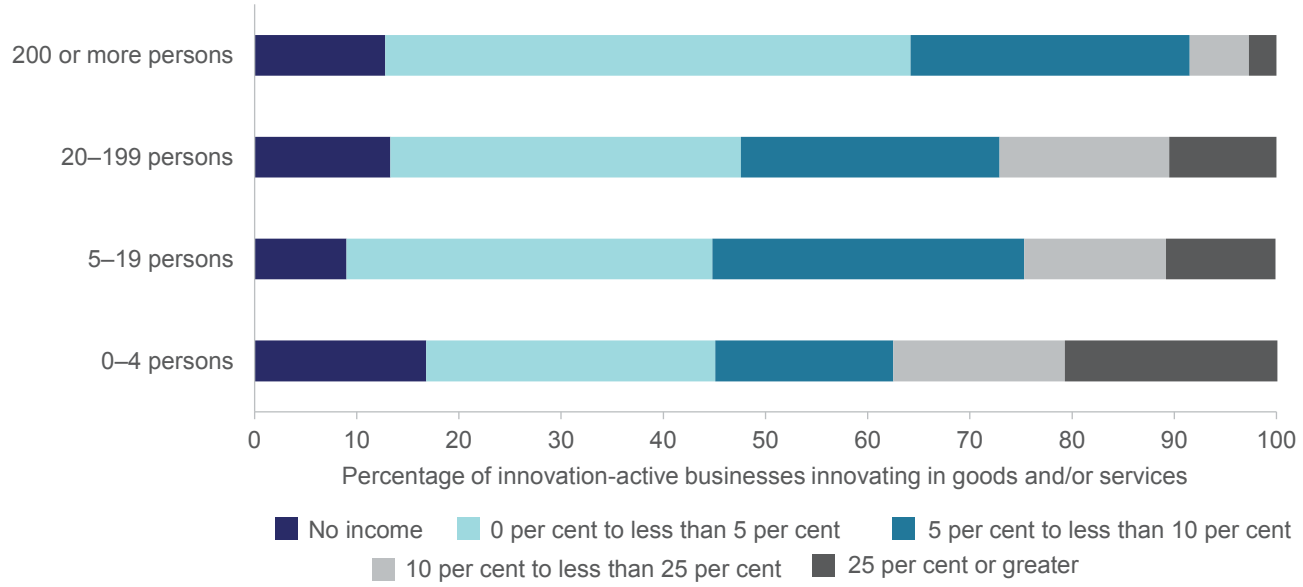
Based on this data, and using Methodology 2.3, we estimate that Australian businesses earned $60 billion from the sale of innovative goods and services introduced in 2014–15. This was approximately two per cent of total sales in that same year. Half of this income was generated by SMEs ($28 billion).

(e) The source data defines 'innovative' as 'new or significantly improved'.

There is significant variation by sector in the income earned from innovative goods and services (Figure 2.8). *Wholesale Trade* ($11 billion), *Manufacturing* ($10 billion), *Finance and Insurance Services* ($10 billion) and *Professional, Scientific and Technical Services* ($6 billion) were the four largest earners from 2014–15 goods and services innovations.

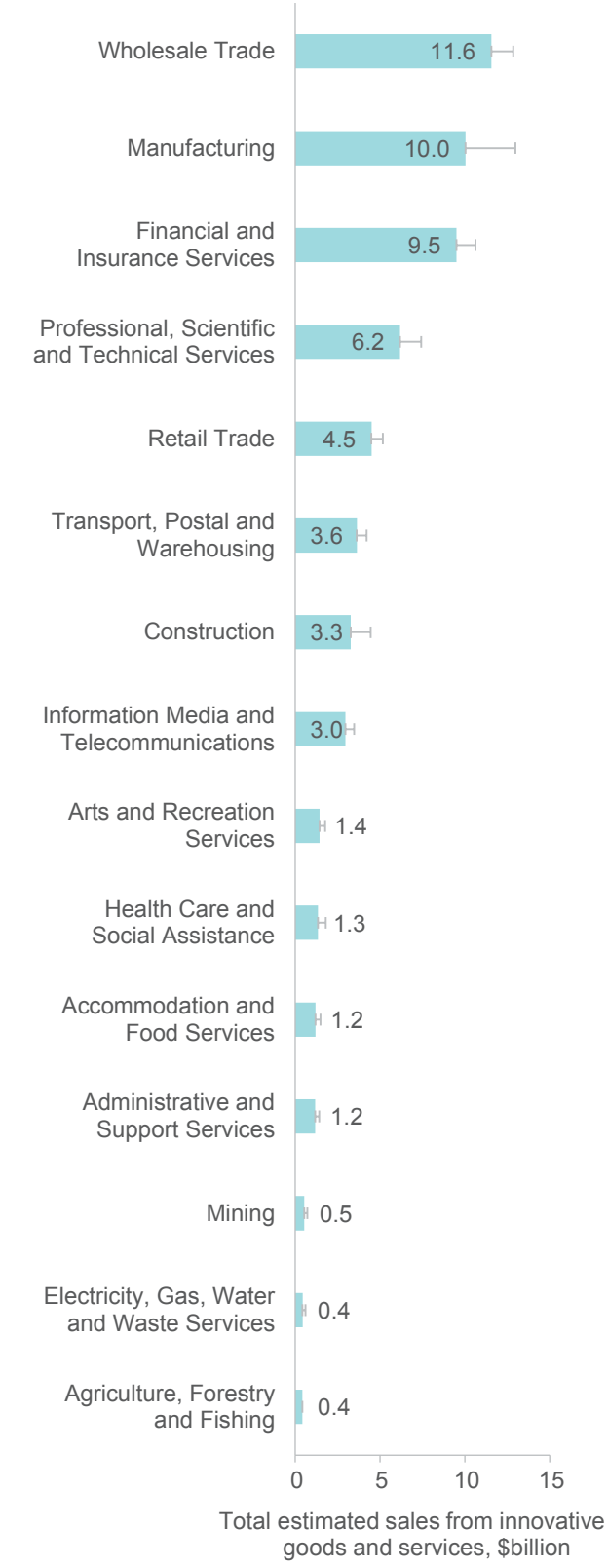
These sectors also tended to earn a higher proportion of their total income from the sale of innovative goods compared to the national average of two per cent. *Information, Media and Telecommunication Services* earned $3 billion from innovative goods and services introduced in 2014–15, which was close to 4 per cent of its total income for that year. Sectors with a smaller share of GDP (for example *Agriculture, Forestry and Fishing*), or that were more likely to undertake process and/or organisational innovations than goods and services innovation (for example *Mining*), did not earn significant income from their new goods and service innovations in 2014–15.

Figure 2.7: Total business income derived from sales of new goods and/or services, by size, 2014–15



Source: ABS (2016) *Innovation in Australian Business 2014–15*, cat. no. 8158.0

Figure 2.8: Total estimated business sales from innovation goods and services, by sector, 2014–15



Notes: Bars are standard errors. Data is unavailable for Rental, Hiring and Real Estate Services; Arts and Recreation Services; and Other Services.

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

Methodology 2.3: Measuring the impact of innovation

For the first time in Australia, businesses were asked the following question in the 2014–15 Business Characteristics Survey:

'What percentage of the income reported in [Q3a: Total Income from Sales from Goods or Services] resulted from new or significantly improved goods or services introduced during the year ended 30 June 2015?'

Businesses were then asked to tick a percentage range.

This question related specifically to the returns from goods or services innovation in the year of introduction. This question is also asked across European Union businesses, allowing us to make international comparisons.

This question does not ask what proportion of total income from goods and services comes from innovations introduced earlier than the reference year.

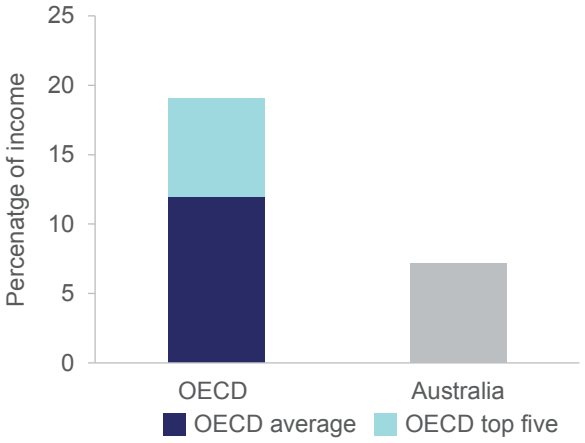
This question will also not capture some of the financial benefits from other types of innovation.

Since the survey is designed to provide a representative sample of the Australian business population, the ABS is able to estimate the national expenditure using mid-points from ranges for each business that answered the question. This is likely to be an underestimate, given that businesses that ticked the range 'Greater than or equal to 25 per cent' was assigned a 25 per cent value in this estimation.

Income from goods and services innovation

Australia appears to earn a relatively low proportion of its total income from innovative goods and services compared with other countries (Figure 2.9). When we match Australian data to the EU Community Innovation Survey industry scope and business size classes, Australia's estimate of the income from new or significantly improved good and services is 7.2 per cent of total sales in 2014–15. With this value Australia ranks 20th out of 23 countries in the OECD, with the OECD top five average being 19 per cent.

Figure 2.9: Share of income from new or significantly improved goods and services, by country, 2012



Notes: Australian business data is matched to the EU Community Innovation Survey industry and size scope. Community Innovation Survey data relates to total sales in 2012. More recent EU data is not yet available. Australian data is for 2014–15. The OECD top five countries are Turkey, Slovakia, Spain, United Kingdom and Denmark.

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

A new measure of innovation system efficiency

The ABS estimates total expenditure on innovation by Australian businesses in 2014–15 was between $26 billion and $30 billion. To calculate these figures, innovation-active businesses were asked to estimate their expenditure (using ranges) on the development or introduction of all new goods, services, processes or methods during the reference period. To estimate the innovation expenditure by all Australian businesses, the ABS assigned a random value to each innovation-active business that reported expenditure within the bounded ranges, combined them with any actual dollar values reported, and weighted the results to derive an innovation expenditure total. This operation was performed multiple times, and the average provides an approximate value of innovation expenditure.

As noted earlier in this section, Australian businesses were estimated to have earned $60 billion in 2014–15 from innovative goods and services. This level of income, combined with the expenditure estimated above, suggests that for every dollar put into innovation by the market two dollars are returned (without making any assumptions about lag effects, additional public sector investment, or trying to model what types of innovations were actually invested in).

This indicates that innovation investment contributes significantly to sales in the private sector. The contribution of innovation is likely to be higher than our estimate, given that:

- the financial benefits of other types of innovation, such as process innovation, are not captured in this indicator and are known to be higher than goods and services innovation
- sales from innovative goods and services introduced in previous years are not measured.

Feature article: CSIRO Futures

Author James Deverell
Director, CSIRO Futures

After decades of economic growth enabled by market-oriented reforms and driven by strong demand for mineral resources, Australia is now facing an uncertain economic future. The investment phase of the mining boom is over. The world is changing rapidly as unprecedented wealth creation shifts the balance of economic power towards Asia. Global demand for exports is expected to treble by 2050.[32] This will create enormous opportunities for Australia. However, at the same time new business models and disruptive technologies are threatening established industries faster than ever before.

Faced with these changes, how will Australia maintain its competitiveness in existing industries and build comparative advantage in new and emerging industries? While this is a complex and multi-faceted question, one of the most important factors will be innovation, particularly in science and technology. The OECD estimates that technological innovation, driven by R&D investment, contributes around 50 percent of GDP growth in developed countries.[33]

Innovation will be important on two fronts. First, it will be key to increasing productivity in existing industries through the application of new technologies, such as automation, data analytics and genetics. This matters because Australia's multi-factor productivity has been in decline for the past decade, and productivity is one of the key drivers of economic growth.[34]

Second, innovation will be a necessary ingredient for developing new industries and new companies through the commercialisation of emerging science and technology. With many of these innovations disrupting existing industries, it will be important to use these breakthroughs to generate new sources of comparative advantage internationally.

However, Australia has a limited window to seize these new opportunities. If we don't, others will. This is the 'innovation imperative'; in a rapidly changing world, Australia risks being left behind if it fails to innovate.

But how do we plan today's innovation investments to meet these future opportunities and challenges? High-growth businesses and governments alike will need to make intelligent, informed decisions about where to invest to get the best outcomes, whether that is return on capital (at a corporate level) or new sources of economic growth and sustainability (at a national level).

In a recent report, Australia 2030: Navigating our Uncertain Future, CSIRO developed a framework to guide strategic planning and innovation investment decisions under uncertain conditions such as those currently facing Australia. The framework is based on CSIRO's 'global megatrends', the long-term social, economic, environmental and technological patterns of change that CSIRO has been tracking since 2009. Australia 2030 presents the most recent iteration of these megatrends, crowdsourced across CSIRO's 5,000 research professionals, and uses them to develop four divergent scenarios for the future of Australia.

The report also outlines key growth opportunities for five core growth sectors across each of the scenarios. By using a scenarios-based approach, these opportunities span a range of future outlooks. CSIRO is now expanding on these opportunities

to develop industry and technology roadmaps that identify how science, technology and innovation can enable these opportunities, and where investments are most likely to accelerate technology adoption.

The framework presented in Australia 2030 can also be applied within high-growth companies to align corporate strategy and innovation investments. The four steps of this framework are summarised below.

The first step of the framework ('Explore') identifies relevant trends and emerging technologies, and uses these to develop a view of the future landscape through a set of custom scenarios. For each of these scenarios, significant opportunities and risks are identified. There is a deliberate focus on identifying long-term opportunities that challenge the status quo and provide sustainable value, rather than 'quick wins'.

The second step ('Choose') assesses and prioritises these opportunities, and uses them to develop an innovation strategy that aligns with corporate strategy. One of the key purposes of an innovation strategy is to guide innovation investment decisions at all levels of the organisation. At a corporate level, it should inform decisions about where the company will be an innovation leader, where it will be a 'fast-follower' and, importantly, where it will deprioritise investment. Within individual business units and projects, the strategy should guide decisions about where to maintain capability in-house and where to partner or outsource.

The third step ('Plan') translates this strategy into a portfolio of technology projects, and identifies the skills, capabilities and resources that will be necessary to deliver against this portfolio. Taking a portfolio approach to innovation allows a company to diversify its investments across a spectrum of innovation activities, ranging from short-term incremental improvements to longer-term breakthrough and disruptive innovations.

The final step ('Create') is about executing against this portfolio of projects by developing the necessary skills, culture and partnerships to create sustainable value from technology. A key component in this step is identifying the right collaboration model and partners that align with the time horizon and intellectual property (IP) outlook of individual projects. An example of this is using exploratory development, such as corporate venturing or start-up accelerator programs, to collaborate on ideas and concepts. This can provide a low-risk and low-cost option to continually test ideas in unproven areas, and to trial relationships with new innovation partners.

These four steps provide a framework for developing an innovation strategy and technology portfolio based on a top-down view of long-term trends and emerging technologies, and a bottom-up view of existing comparative advantage. This approach can be applied at both a national level and within individual companies to identify new opportunities, align innovation investments with long-term strategy, and harness technology to create sustainable growth for the years ahead.

Find out more about CSIRO Futures here.[35]