# The cover page shows a stylised globe made of dots and connections, with Australia in the foreground.

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Content contained herein should be attributed as *Improving Innovation Indicators: Better Data to Track Innovation in Australia.*

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# Message from the Co-Chairs

Like most people in our respective fields, we’d always accepted that innovation was hard to define and even harder to measure, but the measures we had were the best we’d got.

Then a few years ago, an international comparison metric came out that showed Australia was dead-last in collaboration between universities and innovation-active small-medium enterprises, with large enterprises not faring much better. [[1]](#footnote-2)

This finding led to a frenzy of negative commentary.

In discussions with Vice Chancellors and Deputy Vice Chancellors of Research around Australia, it was apparent that each university could present solid evidence of strong industry collaboration, and each thought that the cause of Australia’s low collaboration ranking must lie with the other universities.

Upon further investigation, we found the ranking was misrepresentative, with our position influenced by Australia’s use of different collection methodologies.

Other comparison metrics at that time looking at industry investment and patent investorship put Australia’s collaboration between universities and innovation-active businesses in the middle of the pack.

Not nearly good enough, but far from dead-last.

We needed different policy responses than if Australia had been dead-last.

That is where our investigative journey into Australia’s innovation metrics began.

The Review was commissioned by Government in response to a recommendation in the Innovation and Science Australia 2030 Plan that called for a review of existing innovation metrics for accuracy and adequacy.

We were appointed as Co-Chairs and asked ourselves ‘where should we start?’.

We agreed that to start, we needed to focus on the outcome.

You all know the old joke about a police officer who sees a drunk searching for something under a streetlight and asks what the man has lost. He says he lost his keys and they both look under the streetlight together. After a few minutes the officer asks the drunk if he is sure he lost them here, and the man replies, no, he lost them in the park. The officer asks why he is searching here, and the man replies, ‘the light is much better here’.

The moral: we look where it’s easy, not necessarily where it’s useful.

In our case, the outcome we all want is simple: increased productivity and higher living standards.

Innovation is the key that unlocks them, and metrics are the light with which we find the key.

There were several goals for this Review.

First, the Review sought to improve data sources and metrics that are not quite fit for purpose, are in some way inaccurate, or do not allow direct country comparisons.

Second, the Review sought to identify and fill measurement gaps, to capture hidden innovation.

Third, the Review sought to deliver a list of suitable metrics – what we call a scorecard – that would be of policy relevance to government and useful to guide evidence-based decision-making.

The Review found that:

* many innovation metrics have focussed primarily on measuring R&D activities, as this is where Government policy efforts have been concentrated. However, evidence shows that significant innovation activities are occurring that do not involve R&D, but not all these activities are being measured, and not all the policy levers potentially available to encourage them are being used
* intangible capital is now more important than tangible capital in several developed countries. Its importance is increasing in Australia and internationally, but there are significant gaps in the measurement of intangibles
* measuring digital activities in the economy is also of increasing importance, but where and how the economy has been most impacted by adoption of digital technologies is unknown.

Based on these findings, the Review proposes recommendations to:

* provide leadership of innovation measurement and reporting arrangements for the ongoing maintenance and reporting of innovation metrics including through the use of an innovation scorecard
* address data gaps to support the development and assessment of policy initiatives including where there are deficiencies in the frequency or availability of current data, or where conceptual or measurement challenges exist
* support the analysis of relevant new data, and data already available to the Australian Government that are not being fully utilised.

In adopting the recommendations of this Review, the Australian Government’s ability to measure, report on, and compare the performance of the Australian innovation ecosystem with those of other countries will be greatly improved.

Why is it so important to take these steps now rather than later?

Former British Prime Minister Tony Blair was well known for his mantra ‘education, education, education’.

Twenty years on, a more apposite trifecta would be ‘innovation, innovation, innovation’.

We will in coming years begin to run into natural limits on raising education levels, but we will never run out of ideas about how to do things better. It is innovation that will continue to drive increases in longevity, rein in and reduce carbon emissions, and reverse flagging growth in productivity and living standards.

We can and must get better at innovation in Australia. A precondition for developing successful policy that supports innovation is that we measure innovation well and report on it regularly as part of an ongoing national conversation. What you measure, you optimise.

In setting out a roadmap for change, we aim to ensure the longevity of the changes to the data and measurement capability.

Producing this report required input from many people. We take this opportunity to thank Christine Williams, who led the Review’s taskforce, the taskforce members, the Review’s Steering Committee and Expert Reference Group, the panel of international experts who contributed their advice, the Scorecard Expert Working Group, the Intangibles Expert Working Group, ATSE’s Expert Working Group and Broader Consultative Group, and the hundreds of stakeholders who took the time to consult with the taskforce, or present submissions for the Review.

To each person and organisation who shared their advice and time, we sincerely thank you for your contribution.

**Alan Finkel**

Australia’s Chief Scientist

**Mark Cully**

Head of the Treasury’s Regulatory Reform taskforce

# Executive summary

Innovation is key to improving a country’s long-term prosperity and well-being. However, innovation is a complex concept and is difficult to measure. Policymakers require an evidence base to understand how elements of the innovation system are performing and which areas need attention.

If the Australian Government does not focus on the right metrics for Australia, there is a significant risk that these metrics will inform policy settings, which will result in suboptimal outcomes.

The issue of metric reliability was highlighted in the report of Innovation and Science Australia (ISA) to the Australian Government, *Australia 2030: Prosperity through Innovation.* In response to the ISA report, the Innovation Metrics Review was commissioned by the Australian Government to deliver a series of recommendations regarding how Australia can improve its ability to measure key aspects of its innovation system.

The Review’s aim is to develop a suite of metrics that more fully capture innovation and thereby improve government policy making, program design and evaluation, and overall decision-making.

The Review took a holistic approach to innovation measurement and investigated data sources, metrics, analysis and leadership.

## The findings

Many existing innovation metrics focus on measuring R&D activities, as this is where a large portion of government innovation policy efforts have been concentrated both in Australia and internationally.

However large amounts of innovation activity and expenditure do not involve R&D.

Since these activities are not being adequately measured, the policy levers potentially available to encourage them are not being fully exploited.

Intangible assets are an increasingly important component of investment in developed countries, including Australia, but there are significant gaps in the measurement of intangibles.

Measuring digital activities in the economy is also of increasing importance, but where and how the economy has been most impacted by digitalisation is not well measured.

The Review identified major gaps in innovation data capture, metrics and analysis. These are discussed in this report. These information gaps and emerging data needs have been discussed under three themes:

* Areas of the innovation system where the concepts and measures in place are fit-for-purpose, but there are gaps related to the frequency and or granularity of current data
* Areas where there is a sound conceptual basis for measurement, but measurement challenges weaken data utility
* Areas where there are both conceptual and measurement challenges.

## The recommendations

The Review made several recommendations that can be implemented to improve the current state of innovation measurement in Australia.

### Regular measurement of the Australian innovation system with a scorecard.

National innovation systems are complex. Scorecards can cut through the complexity and quickly communicate the most important aspects of innovation.

Scorecards can underpin public discussion about where policymakers might usefully intervene.

Research by the Productivity Commission shows that productivity growth is a key factor in determining a country’s standard of living. The Review has developed its Scorecard based upon the Productivity Growth Framework developed by the Productivity Commission. There is already a strong relationship between innovation, productivity growth and improved living standards. In developing its Scorecard, the Review therefore sought to align the measurement of innovation performance to where innovation policy can have the greatest impact on living standards.

The resulting Scorecard contains a handful of the most important indicators for monitoring innovation-driven productivity gains in the economy. The indicators are mapped against the drivers of productivity growth, given limitations on the data available to underpin them.

The Review recommends that an Innovation Metrics Scorecard should be reported annually to Government and regularly reviewed.

### Better data and metrics for measuring innovation

Addressing information gaps and emerging data needs will require statistical, analytical and research solutions to be investigated and developed.

Many of the information gaps and emerging data needs highlighted by the Review are not unique to Australia. In many respects Australia is comparable to other countries in regard to data gaps. Since many National Statistical Offices (NSOs) are experiencing the same innovation measurement challenges, there is an opportunity to coordinate efforts to develop solutions.

### Ongoing analysis of the innovation system

Due to the complex and dynamic nature of innovation systems, data and metrics alone are not enough to capture relevant innovation activities with enough clarity to provide insights for policymakers.

Analysis of data is important to identify the linkages through various innovation activities. There are several reasons why analysis of data is important; it can provide deeper insights on innovation system performance and impacts; it can assess existing information measures and identify new and emerging needs and information gaps; and it can maximise the value of the large amounts of data being generated.

Data analysis provides insights into the enablers of innovation activities of critical importance to jobs, productivity growth, and social and environmental impacts. There are some important data already collected that are not being analysed that should be, due to visibility and access issues. The Department of Home Affairs’ trade data, which flag new to world and new to business Australian exports, were amongst these until recently. They were made accessible to analysts outside that Department through the Business Longitudinal Analysis Data Environment (BLADE) in October 2019.

### Leadership in innovation measurement

Responsibility for Australia’s innovation ecosystem, and for measuring its progress, is currently split across Australian, state and territory agencies. This makes the development of a national strategic approach for measuring innovation difficult and time consuming.

There should be an appointment of a single entity with a whole-of-government remit to provide national leadership of innovation measurement and reporting.

## What’s next

The Review has set out a roadmap to implement the recommendations of the Review.

These recommendations target strategic priorities and take a common sense approach to implementation to improve the measurement of innovation in Australia. Implementing the recommendations will require long-term support.

Two of the high priority recommendations are time sensitive as they relate to ongoing ABS survey work. These two recommendations should be implemented quickly to align with the timeframes of existing activities that they are leveraging.

Other recommendations are not as time-critical, however, the net benefits expected cannot be realised unless they are implemented.

Some of the Review’s recommendations also provide direction on next steps, rather than presenting final solutions.

# Findings

Evidence gathered by the Review shows that there is a substantial amount of innovation activity and expenditure occurring in the economy that does not involve R&D.

The Review also uncovered that significant amounts of non-R&D innovation activities and expenditures are not being captured in current measures. The Review found evidence of widespread under-reporting of continuous incremental improvement in business processes across all four sectors examined. It also found some sector-specific under-reporting (such as de-risking in mining and extension in agriculture).

* Internationally, government innovation policies have a focus on promoting R&D based activities, and as a result tend to focus on sectors of the economy that invest more heavily in R&D, such as advanced manufacturing and medical research
* Australia’s areas of comparative advantage – including resources, education, tourism, and agriculture – are different from those of Europe. The resources, tourism and agriculture industries around the world have relatively low R&D expenditure as a percentage of revenue
* Measures of expenditure on R&D are important, but on their own are insufficient to provide a complete picture of the breadth of innovation activities occurring in the Australian economy. In Australia, non-R&D innovation expenditure is of a similar order of magnitude to R&D expenditure, and is more common (in that more businesses engage in it).

Intangible assets are an increasingly important component of investment in developed countries, including Australia, but there are large gaps in the measurement of intangibles.

* Intangible capital consists of assets that lack physical substance; in contrast to physical assets (such as machinery, land and buildings), and financial assets (such as government securities). Intellectual property (IP), goodwill and brand recognition are all examples of intangible assets
* There are significant gaps in the measurement of intangibles. These gaps are due to their exclusion from international standards such as the System of National Accounts (SNA), to which Australia adheres. For example, we do not directly capture the value of data created (just the cost of collecting it), although this value is indirectly captured in GDP
* Other gaps include design and other product development, training, market research and branding, business process re-engineering, and networks.

Measuring digital activities in the economy is also of increasing importance, but where and how the economy has been most affected by digitalisation is unknown.

* The sectoral studies provided qualitative evidence that Australian businesses are investing heavily in digitalisation
* However, there is little quantitative evidence available regarding investment in and take-up of digital technologies and the impact of these technologies on the Australian economy

The Review identified gaps in innovation data, metrics and analysis, which are discussed in this report. These information gaps and emerging data needs have been captured under three themes:

* Areas of the innovation system where the concepts and measures currently in place are fit-for-purpose, but where there are gaps related to the frequency or availability of current data
* Areas where there are sound conceptual grounds for measurement, but where measurement challenges reduce data utility
* Areas where there are conceptual and measurement challenges.

There are also areas where data are available and fit-for-purpose but have not yet been analysed.

The Review developed the Scorecard to track Australia’s current innovation performance.

* The Review mapped innovation metrics to the drivers of productivity growth identified in the Australian Productivity Commission’s analysis of innovation
* The Scorecard contains a handful of the most important indicators for Australia, based on currently available data, for monitoring innovation-driven productivity gains in the economy (see the attached Scorecard)
* The Review visually represented the drivers of productivity growth to show how innovation feeds into productivity improvements
* The Review also highlighted the policy levers that can foster improvements in economic prosperity via the innovation system in Australia.

# Recommendations at a glance

## Measuring the performance of the Australian innovation system

| **RECOMMENDATION 1.1: INTRODUCE ANNUAL INNOVATION SYSTEM REPORTING** |
| --- |
| The Review recommends that an appropriate entity responsible for innovation measurement in Australia should produce an innovation metrics scorecard and provide a report to the Australian Government annually.  Every year the responsible entity should provide:   * a publicly available report on the performance of the innovation ecosystem in Australia * an innovation metrics scorecard that measures progress domestically and benchmarks Australia’s performance internationally.   The Scorecard developed by the Review should be adopted until improved innovation data becomes available (a minor update for some of the metrics will be needed in the second half of 2021).  Future periodic reviews should be undertaken from the second half of 2022 to inform the approach for developing an updated scorecard. |

## Data and metrics for measuring innovation

| **RECOMMENDATION 2.1: IMPROVE MEASURES OF EXPENDITURE ON R&D** |
| --- |
| The ABS should produce annual indicators of Gross Expenditure on Research and Development (GERD) and Businesses Expenditure on Research and Development (BERD), including estimates of R&D expenditure at a more granular level than is currently available. |

| **RECOMMENDATION 2.2: IMPROVE MEASURES OF BUSINESS USE OF DIGITAL TECHNOLOGIES** |
| --- |
| The ABS should update current survey content related to business use of digital technologies to reflect new technological advances and measure the extent of technology diffusion and its impact on business performance.  The ABS should also leverage work being done internationally that measures the link between the diffusion of these new technologies and their impact on innovation.  The responsible entity should investigate the feasibility of accessing and using alternative sources of data (e.g. Big Data analytics, administrative and transactional data) to provide new and complementary indicators of the extent of business adoption and use of digital technologies. |

| **RECOMMENDATION 2.3: IMPROVE MEASURES OF BUSINESS INNOVATION ACTIVITIES** |
| --- |
| The ABS should review the collection of business innovation data and make sure it aligns better with that of other countries so that direct comparisons can be made.  The ABS should ensure any changes made continue to meet the needs of other users of the data and are useful in the context of the Australian economy. In particular the ABS should:   * introduce a standalone Australian business innovation survey, administered every two years using a two-year reference period, to enable more meaningful international comparisons to be made. This survey would be mandatory, as is the practice with other ABS business surveys * investigate ways to increase the utility and meaningful measurement and analysis of total business innovation expenditure * investigate the feasibility of developing broader measures of how businesses work together for the purpose of innovation, including fee-for-service arrangements * provide a more complete picture of the impacts of innovation activities occurring in Australian businesses. |

| **RECOMMENDATION 2.4: CONDUCT AN ANNUAL SECTORAL ANALYSIS** |
| --- |
| The responsible entity should commission an annual large-scale sectoral study to develop a better understanding of the nature of innovation in those sectors that are important to the Australian economy. This study should:   * draw comparisons with a selection of countries that are relevant to the sector being analysed (e.g. for the mining sector, comparison countries should include those with major mining activity) * start with a sector that is important to the Australian economy and rotate annually to a different sector. |

| **RECOMMENDATION 2.5: UPDATE OCCUPATION CLASSIFICATION SYSTEM** |
| --- |
| The ABS should review and update the Australian and New Zealand Standard Classification of Occupations (ANZSCO) for new and emerging occupations that are expected to have increasing importance. |

| **RECOMMENDATION 2.6: UPDATE INDUSTRY CLASSIFICATION SYSTEM** |
| --- |
| The ABS should continue to engage with the United Nations Statistical Commission regarding the International Standard Industrial Classification (ISIC), with a view to influence any update to:   * better reflect the Australian economic structure * facilitate meaningful sector analysis * aid evidence-based decision-making.   The ABS should continue to engage with the United Nations Statistical Commission and the Organisation for Economic Cooperation and Development to influence the development of a more streamlined and flexible way of conducting updates of industry classifications  The ABS should review and update the Australian and New Zealand Standard Industrial Classification (ANZSIC) after the 2021 Census. |

| **RECOMMENDATION 2.7: INTRODUCE AND IMPROVE MEASURES OF INTANGIBLE CAPITAL** |
| --- |
| The ABS should develop experimental estimates of intangible capital items not covered within the System of National Accounts (SNA).  The ABS should review and update the data sources and assumptions underlying intangible capital measurement within the SNA. |

| **RECOMMENDATION 2.8: INTRODUCE AND IMPROVE MEASURES OF DIGITAL ACTIVITIES IN THE ECONOMY** |
| --- |
| The ABS should leverage work undertaken internationally and assess how digital activity measures can be developed, prioritising the following information needs:   * The total value of e-commerce (digitally ordered goods and services) * The level of investment in digital technologies (such as cloud computing) occurring in the economy * The total value of services provided by intermediary platforms as a separate proportion of the overall value of goods and services being provided by the producer * The imputed value of free services (including data) not currently captured within the SNA.   In the longer term these measures may contribute to a future digital satellite account. |

| **RECOMMENDATION 2.9: MEASURE GOVERNMENT INNOVATION ACQUISITION** |
| --- |
| The Australian Government regularly enters into arrangements to acquire new or significantly improved products (goods and services) and processes. At present it does not differentiate arrangements for acquisition of these innovative products and processes from other products.  Investigation, organised by the responsible entity, is needed to determine how data on government acquisition of innovative products and processes could be collected, in order to measure their worth and effect on encouraging innovation. Ideally, an approach that enables international comparison of performance should be adopted. |

| **RECOMMENDATION 2.10: INTRODUCE AND IMPROVE MEASURES OF ENTREPRENEURSHIP; START-UPS AND SPIN OUTS** |
| --- |
| Work is needed to define the conceptual basis for measurement and develop measurement systems that enable conclusions to be drawn about the level, performance and drivers of entrepreneurial activity in Australia and other countries.  The responsible entity should coordinate this work drawing on expertise from the international and domestic research community, relevant policy areas and other stakeholders. |

| **RECOMMENDATION 2.11: IMPROVE MEASURES OF ACCESS TO FINANCE FOR START-UPS** |
| --- |
| The responsible entity should investigate the compilation and connection of alternative public and private data sources for the measurement of access to finance; including use of angel investment, crowd-sourcing and accelerators. The investigation should assess whether there is an alternative to the Venture Capital and Later Stage Private Equity (VC&LSPE) Survey to meet the need for data on access to finance over the longer term.  In the interim the ABS should continue to undertake the VC&LSPE Survey. |

| **RECOMMENDATION 2.12: MEASURE LOCATION-BASED INNOVATION** |
| --- |
| The responsible entity to investigate options, by working with the ABS and other relevant parties, to build location-based capability into Australian innovation data. Data custodians should be encouraged to collect location data that supports analysis of location-based innovative activity. |

| **RECOMMENDATION 2.13: IMPROVE MEASURES OF RESEARCH COMMERCIALISATION** |
| --- |
| The collection of data through the National Survey of Research Commercialisation by the Department of Industry, Innovation and Science should be discontinued.  The responsible entity should coordinate the development of a conceptual framework for the measurement of research commercialisation activities. This should focus on measuring the success of publicly funded research organisations, in commercialising their ideas in conjunction with the business community.  The responsible entity should commence the collection of hitherto unavailable research commercialisation data. The entity will ensure this data can be properly measured and is important to stakeholders. |

## Analysis

| **RECOMMENDATION 3.1: TAKE A WHOLE-OF-GOVERNMENT APPROACH TO INNOVATION RESEARCH** |
| --- |
| The responsible entity should take a whole-of-government approach to innovation research, drawing on capabilities across Australian, state and territory government agencies, academia and the private sector.  The aim would be to build strong analytical capability regarding Australia’s innovation ecosystem. |

## Leadership on innovation measurement

| **RECOMMENDATION 4.1: ASSIGN RESPONSIBILITY FOR LEADERSHIP OF INNOVATION MEASUREMENT** |
| --- |
| Appoint a single entity with a whole-of-government remit, to provide national leadership for innovation measurement and reporting.  This leadership role will entail:   * collaborating with stakeholders to identify and address data and metrics gaps and ensure the continued relevance of innovation data and metrics while considering Australia’s changing economy, society and environment * reporting to the Australian Government on the progress of the implementation of recommendations proposed in this Review * ensuring Australia is represented in international efforts to improve innovation, science and technology measurement * being a single point of contact to facilitate international engagement on innovation measurement issues * allocating work through contract management to enable it to perform these functions.   This leadership role will not entail:   * collecting data directly * conducting research directly.   The entity would collaborate with the ABS to ensure new data and metrics were consistent with international work where appropriate. |

# Introduction

|  |
| --- |
| KEY POINTS   * The Australian Government commissioned the Innovation Metrics Review (the Review) to improve innovation measurement to support better decision-making * The Review aims to take a holistic approach to innovation measurement and covers issues including metrics, data sources, analysis and leadership * Innovation is a complex concept and is difficult to measure. |

## There is no community consensus on the scope and definition of innovation

Innovation is a critical element of our modern society and we feel its influence everywhere.

Technology that was in its infancy 10 years ago, such as smartphones and electric cars, is far more advanced today.

Innovation is happening all the time, however innovation is a complex concept and there are many different definitions and interpretations of what innovation means.

The OECD’s Oslo Manual, first issued in 1992 and updated at intervals since then, provides guidelines for collecting, reporting and using innovation data.

The 2018 Oslo Manual defines innovation as:

“A new or improved product or process (or combination thereof) that differs significantly from the unit’s previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)”[[2]](#footnote-3)

However, even with this definition there are problems.

Innovation activities by their nature are novel and varied. For instance, innovation is undertaken in diverse ways across different sectors of the economy. This has led to actors in the innovation system having their own definitions of what constitutes innovation.

## Innovation is important for improving a country’s long-term prosperity and well-being

Innovation is a key source of long-term prosperity and well-being. Analysis by the OECD found that innovation often contributes over half of GDP growth in member countries.[[3]](#footnote-4) In addition to economic benefits, innovation propels substantial improvements in living standards through advances in areas such as healthcare, education and infrastructure.

Measuring the benefits from investment in innovation is a priority for governments around the world.

As growth has slowed in many developed economies, governments are now turning to innovation as a key source of future growth.

Policymakers require an evidence base to understand how elements of the innovation system are performing and which areas need attention.

If the Australian Government does not focus on the right metrics for Australia, there is a significant risk that these metrics will inform policy settings, which will result in suboptimal outcomes.

As Joseph Stiglitz observed,

‘If we measure the wrong thing, we will do the wrong thing. If we don’t measure something, it becomes neglected, as if the problem didn’t exist’[[4]](#footnote-5)

It is vital that the most relevant metrics are used to focus innovation policy on areas that maximise positive economic, social and environmental outcomes for Australia.

## Concerns with current international innovation measures have led to a review of metrics in the Australian context

There are many indicators used to benchmark innovation, however concerns have been raised about the reliability of some of these measures to compare Australia‘s performance internationally.

There is a perception that Australia performs poorly regarding business collaboration with the research sector and with business expenditure on research and development (BERD).

Figure i.1: Business expenditure on research and development (BERD) of OECD countries in 2017, percent of GDP

| The figure shows business expenditure on research and development of OECD and other countries in 2017, as a percent of GDP, ordered from highest to lowest. The country with the highest spend as a percent of GDP is Israel at 3.91. Korea is second at 3.62. The average of the top five countries is 2.96. Australia is well down the list, at 0.94. The list concludes with Latvia at 0.14 and Chile at 0.12. |
| --- |

Source: OECD Main Science and Technology Indicators; Accessed 20 September 2019

Although this may be the case, it is unclear if these are useful assessments of Australia’s innovation performance on their own, given that Australia remains an extremely competitive exporter in key sectors, such as mining, agriculture and education.

In isolation, giving too much weight to indicators like BERD as percentage of GDP to compare innovation performance across countries may be misleading because of differences in the structure of national economies. The level of investment in BERD varies by industry and hence the BERD of a country is affected by the composition of its economy. For example, at a global level, advanced manufacturing is a sector characterised by high BERD, and mining and agriculture are sectors characterised by low BERD (even though mining is a relatively high BERD sector by Australian standards).

Countries such as Germany with a comparative advantage in advanced manufacturing, will naturally tend to have a higher BERD than countries such as Australia with comparative advantages in agriculture and mining, which are characterised by low BERD.

Previously, The Treasury report into Australia’s international R&D efforts explained that Australia’s low BERD has a significant relationship to Australia’s industry structure.[[5]](#footnote-6) This deduction is supported by the forthcoming report by AlphaBeta that notes that over 90 percent of the decline in BERD as a share of GDP since its peak in 2008–09 was the result of Australia’s changing industry mix and a decline in mining exploration and development after the mining boom of the early 2000s.[[6]](#footnote-7)

It has been anecdotally argued that the level of investment in BERD is affected by the size of businesses in the Australian economy. As shown in Figure i.2, Australia also has a slightly higher proportion of persons employed by small and medium enterprises (SMEs, 1–249 employees) than other nations, and a higher than average proportion of persons employed by smaller businesses (1–19 employees).

Figure i.2: Proportion of persons employed in companies of OECD countries according to the size of the company in 2016

| The figure shows the proportion of persons employed in companies of OECD countries according to the size of the company in 2016. Australia has more in the 1-19 persons employed range than the OECD average, less in the 20-249 persons employed range, and slightly less in the 250+ persons range. However, Australia is broadly speaking in the main pack of countries. Australia is not an outlier like Greece, which has a lot more in the 1-19 persons employed range and a lot less in the 250+ persons range. Nor is Australia like the UK, which has a lot more in the 250+ persons employed range. |
| --- |

Notes: Sector coverage includes the business economy, except financial and insurance activities. Australian size class 20–249 employees refers to businesses with 20–199 employees.

Source: OECD Structural Business Statistics (ISIC Rev. 4)

This effect can also be seen in measures of revenue (see Figure i.3). Australian smaller businesses (those with 1–19 employees) have a higher revenue compared to the OECD average.

Figure i.3: Proportion of revenue in companies of OECD countries according to the size of the company in 2016

| The figure show the proportion of revenue in companies of OECD countries according to the size of the company in 2016. Relative to the OECD, Australia has slightly more revenue from companies with 1-19 persons employed and from 250+ persons employed, and less from companies with 20-249 persons employed. However, Australia is broadly speaking in the main pack of countries. The outliers are Estonia and Greece. These have a high proportion of revenue from companies with 1-19 persons employed. |
| --- |

Notes: Sector coverage includes the business economy, except financial and insurance activities. Australian size class 20–249 employees refers to businesses with 20–199 employees.

Source: OECD Structural Business Statistics (ISIC Rev. 4)

SMEs tend to have proportionally lower BERD than larger enterprises. Australia also has fewer multinational research headquarters relative to other developed countries (noting it has some, including CSL, Resmed, and Cochlear, for example), which could also be expected to result in a lower BERD. However, the net effect from this is minor. Australia is not an outlier with regard to small business employment, as Greece is, and its lower BERD has more to do with the structure of the Australian economy.

OECD measures tend to focus on activities and sectors that are not major drivers of the Australian economy, such as advanced manufacturing, and not those, like agriculture and mining, that make a big contribution in Australia.

As in other industrialised economies, services now make up a large part of the Australian economy, representing over 80 per cent of Australia's GDP.[[7]](#footnote-8)

Anecdotal evidence from the sectoral studies suggests that knowledge-intensive and human capital-related investments are more important to innovation in the services sector than physical capital intensive investments and R&D.

The under reporting of the level of innovation in these Australian sectors found by the Review in its sectoral studies discussed in Appendix B, points to further challenges around the international measurement of innovation.

Many innovation indicators focus on the use of established metrics, such as patents and R&D expenditure. However, this provides an incomplete picture of Australia’s innovation performance and there are many other areas considered just as critical for success.

These include but are not limited to:

* the contribution of human capital, management practices and business organisation such as entrepreneurship, intrapreneurship and improvements to workplace culture
* the value of intangible investment such as design, market research, branding and digital platforms
* the influence of hidden innovation such as improvements to processes which are not properly captured and just considered to be business as usual.

These issues are not unique to Australia.

In addition, concerns have been raised about inconsistencies in reference periods and time lags before data are published. Many innovation indicators are lagged indicators – they capture historical data on activities that have already happened, rather than measuring current performance or predicting future performance.

These lags mean policymakers are making decisions based on old information.

The result can be a lack of clear direction for innovation policy interventions, with policies either overcompensating or failing to correct for poor innovation performance.

This could impede the effectiveness of government policy that was supposed to lift Australia’s economic performance and standard of living.

There are also concerns about the definition of collaboration used by the OECD in the Oslo Manual in the Australian context.

Fee for service arrangements are not captured by current international collaboration indicators, but were very common in the sample of Australian businesses that participated in the Review’s sectoral studies, discussed in Appendix B. Fee for service arrangements were routinely used even when risks and IP are being shared.

It is not known whether this is a significant issue, but the sectoral study results indicate it should be investigated.

The issue of metric reliability was highlighted in the report of Innovation and Science Australia (ISA) to the Australian Government, *Australia 2030: Prosperity through Innovation* that recommended a Review be undertaken of the metrics currently being used to assess innovation performance.[[8]](#footnote-9)

## The Review aims to improve innovation metrics and the evidence base for effective policy

In response to the ISA report, the Review was commissioned by the Australian Government to deliver a series of recommendations regarding how Australia can improve its ability to measure key aspects of its innovation system.

The Review’s aim is to develop a suite of metrics that more fully capture innovation and thereby improve government policy making, program design and evaluation, and overall decision-making.

## Goals and principles of the Review

The Review’s co-Chairs established a set of goals and principles to provide the context for considering innovation and to help direct the approach taken during the Review.

The goals and principles were refined and agreed with the international Steering Committee. The key deliverables and scope of the Review are given in Appendix A.

### Goals

The Review set out to deliver a report to the Australian Government recommending:

* An appropriate data and measurement infrastructure for capturing innovation metrics that:
  + is underpinned by a sound conceptual framework
  + captures data at the most efficient cost
  + sets out a roadmap for change.
* A suite of robust innovation metrics that:
  + accurately measure and communicate innovation performance and its effects across all sectors of the Australian economy
  + are presented in a way that is useful for government policy and program development
  + can measure the impact of government policy initiatives on innovation
  + may be useful for international adoption and comparisons.

### Principles

The Review recognised the breadth of benefits that innovation delivers to society, but focused on the economic influences of innovation.

The task of innovation in this review is to drive growth in jobs, productivity, investment and exports.

The Review saw innovation in the context of a modern economy characterised by an increasing dominance of service industries, high levels of investment in intangible capital and deployment of digital technologies.

A key assumption was that Australians want the benefits of innovation from wherever it is sourced – for example, in sectors such as mining and agriculture – which means the Review was open to all sources of innovation including hidden innovation.

A mapping exercise would demonstrate which of the existing metrics in use are of sufficient quality and where new metrics need to be developed to fill gaps.

The starting position for the framework is in the *Australia 2030: Prosperity through Innovation* report.

Metrics must be directly relevant to government policy development and program performance.

Ultimately high-level metrics would be presented in a scorecard with around 15 useful indicators.

The full suite of metrics would serve broader purposes in monitoring, evaluation and research on the innovation system and the impact of government policy.

Where metrics are also collected and published internationally for advanced economies, these would be favourably considered. The recommended metrics should aspire to be internationally comparable with minimal correction required.

It was anticipated that the Review would recommend significant changes to the capture of innovation metrics. Where appropriate to do so, these would leverage off existing statistical collections and administrative data sources, but not shy away from using novel sources.

In setting out a roadmap for change, the Review would aim to ensure the longevity of the changes to the data and measurement infrastructure remain in place to 2030 and beyond.

Underpinning all of the above was the principle of pragmatism.

The Review’s recommendations would be practical, achievable, have due regard for the burden imposed on data providers, and would focus on the most important improvements that could be made.

## Structure of the report

The report takes a holistic approach to innovation measurement and covers data sources, metrics, analysis, and leadership issues.

The Review process and methodology sets the scene for innovation measurement and outlines the methodology used to guide the Review.

Chapter 1 explores the importance of measuring Australia’s innovation system performance including benchmarking internationally.

It notes the key issue of communicating the performance of the Australian innovation ecosystem to a broad audience. It provides a scorecard with a small number of high-level indicators that have been developed in close consultation with key stakeholders and experts in the field.

The Review’s scorecard (the Scorecard) reflects the close relationship between innovation and productivity growth in driving improvements to living standards and long-term prosperity.

Chapter 2 explores the importance of data. It is critical to ensure that data are meaningfully used, and that collection is coordinated. Vast amounts of data are already being collected.

However, there are data gaps and problems associated with collection and measurement. Gaps have been identified in several areas:

* Where there are no conceptual or measurement challenges, but existing data are low quality. For example, the coverage of data on the diffusion of digital technology is too narrow
* Where there is a sound conceptual basis for measurement, but measurement challenges exists. For example, genuine collaborations may be excluded from measurement because fee for service arrangements are excluded
* Where there are conceptual and measurement challenges. For example, some components of intangible capital are not measured, and it is not clear how best to do so.

Opportunities exist to fill gaps in data collection using both quantitative and qualitative approaches. The report explores substantial changes in data collection that ensure all innovation activity is properly captured, particularly in new and emerging fields.

Chapter 3 highlights the importance of analysis that builds on data to inform policy making.

The improved collection of data and reporting of metrics alone is not enough to facilitate policy and business decisions to improve innovation performance.

Meaningful analysis is required to identify trends and other key issues that can inform the development of effective policies. There can be considerable time lags and difficulties in directly attributing a specific activity as a driver of innovation, which could be the result of a combination of factors.

The Review shows how increased analysis of data will improve Australia’s ability to identify relationships that deliver outcomes in key areas, such as jobs, productivity growth, health, education and broader social and environmental benefits.

The Review also explores how to improve policy making through evidence-based analyses by making existing Australian, state and territory government innovation-related datasets available for analysis.

Chapter 4 highlights the importance of leadership on innovation metrics. Collection and publication of innovation metrics is currently very fragmented with many competing stakeholders and priorities.

The Review suggests a model of a national, coordinated, non-partisan and non-competitive entity to align and link innovation measurement efforts.

The Review shows the benefits of annual public reporting on innovation performance as well as progress in the implementation of the recommendations in the report.

The Review explores the provision of a central point of contact to participate in international discussions on innovation measurement issues.

Chapter 5 sets out the steps required to build on the momentum of the Review, including a roadmap for change that identifies priorities for the improvement of measurement of innovation in Australia.

The Review prioritises activities that should be supported over the immediate, medium and long-term.

The Review introduces a timeline for the implementation of recommendations in the report, as well as guidance on when the Scorecard should be reviewed to ensure it continues to capture the most important aspects of innovation for Australia.

There are areas recommended for further work beyond the Review.

As the economy continues to evolve, it is essential that innovation measures continue to remain relevant and guide improvements in the right direction. This will ensure that Australia’s ability to harness both existing and emerging opportunities is maximised.

Finally, the following documents on the key activities that served to provide information underpinning the findings and recommendations of the Review, can be found in the appendices.

These are:

* Appendix A: Scope of the Review
* Appendix B: Sectoral studies
* Appendix C: Updated improving innovation indicators consultation paper, following the public submission process
* Appendix D: Innovation Metrics Review Workshop Proceedings 13–14 March 2019
* Appendix E: The Australian Academy of Technology and Engineering’s (ATSE)’s Innovation Metrics Review literature review
* Appendix F: Compendium of metrics
* Appendix G: Governance of the Review
* Appendix H: Scorecard metrics descriptions and data coverage
* Appendix I: Sources of data and metrics currently available
* Appendix J: Priority ordering of the recommendations

# The Review process and methodology

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| KEY POINTS   * The Review has focused on innovation measurement areas that are required to support government decision-making * A Steering Committee and Expert Reference Group, along with selected international innovation measurement advisers, guided the work of the Review. The Review was also guided by separate Expert Working Groups with regard to the Scorecard and Intangibles. The ATSE was guided by an Expert Group of ATSE Fellows * The Review undertook the following activities:   + **Consultation with stakeholders**   + **Sectoral studies**   + **International workshop**   + **Literature review, prepared by ATSE**   + **Assessment of innovation metrics**   + **Gap assessment**   + **An assessment of how to fill the gaps identified.** * The Review adopted an innovation metrics framework to identify the full range of activities and complexities that make up the innovation ecosystem * The innovation metrics framework is central to the Review’s assessment of innovation metrics which informed the findings and recommendations of the Review. |

## Review of Australia’s measurement of innovation

The ISA report to government, *Australia 2030: Prosperity through Innovation,* raised questions about how measurement of the performance of the innovation system can be improved.[[9]](#footnote-10) ISA called for a Review of the existing innovation metrics for accuracy and adequacy.

In response to this recommendation, the Australian Government commissioned the Review to deliver a series of recommendations on how Australia can improve its ability to measure key aspects of its innovation system.

This chapter outlines the process and methodology used to inform the findings and recommendations of the Review.

### Governance of the Review

The Review was funded by the Department of Industry, Innovation and Science (the Department), and undertaken by a taskforce consisting of officers from the Department, the Office of Innovation and Science Australia (OISA), Office of the Chief Scientist, the ABS, IP Australia, and ATSE.

ATSE’s role was to provide an independent viewpoint, whilst working in close collaboration with the taskforce, to ensure the Review was robust and considered a broad range of viewpoints. ATSE was commissioned to undertake a literature review and advise on a framework to measure and track innovation; the data currently available, including gaps, and the metrics to be used or developed for future use.

The taskforce was directed by a Steering Committee, and received advice from an Expert Reference Group, international technical advisers, separate Expert Working Groups with regard to the Scorecard and Intangibles. ATSE was guided by its own Expert Working Group and feedback from its Broader Consultative Group. The members of those are listed in Appendix G.

The Review undertook the following activities to inform its findings and recommendations:

* Consultation with stakeholders
* Sectoral studies
* International workshop
* Literature review
* Assessment of the quality of innovation metrics
* Gap analysis of data and metrics
* An assessment of how to fill the gaps identified
* Development of a scorecard of the best metrics available.

### Stakeholder and public consultations

The Review held meetings with key stakeholders to help identify gaps, issues and opportunities for innovation metrics.

Consultations were conducted with:

* international statistical and government agencies
* international innovation measurement experts
* academics and the higher education and research sectors
* Australian Government agencies, including agencies within the DIIS portfolio
* state and territory government officials
* private sector organisations
* the general public, via the public submission process.

The insights gained from those meetings were incorporated into the *Improving Innovation Indicators Consultation Paper,* which was provided to the public for feedback on 7 March, 2019.

The public submissions provided feedback concerning the key messages that emerged from the initial stakeholder consultations, as well as other themes or issues that had not yet been raised. The *Improving Innovation Indicators* *Consultation Paper* was updated in June 2019 to include feedback from written submissions to the Review (see Appendix C). The paper reflects the Review’s consultation process and content at that point in time.

In total, meetings were conducted with 94 organisations. Submissions were received from 36 organisations and individuals, and over 200 people were consulted. The breakdown of interviews by organisation type and by individual is shown below. For example, suppose a private sector business was consulted in one interview involving three representatives of that business. The number of organisations consulted and the number of private sector organisations consulted would each increase by one, but the number of individuals consulted and the number of private sector individuals consulted would each increase by three.

### A workshop was conducted to inform the Review about international developments

An International Innovation Metrics Workshop was held on 13–14 March, 2019 in Canberra. The 51 invited attendees included innovation metrics experts and innovation system stakeholders, and included most of the members of the Review’s governance and advisory bodies.

The purpose of the workshop was to inform the Review about international developments and share the thinking of international and domestic experts on how innovation measurement could be improved.

There were eight thematic sessions at the workshop, with each session introduced by a pair of speakers. These themes included:

* Entrepreneurship
* Innovation metrics – state of play: a World Intellectual Property Organisation’s Global Innovation Index perspective
* Hidden innovation in mining
* Measurement of R&D and innovation policies
* Creative inputs into innovation
* Knowledge diffusion and research commercialisation
* Intangibles
* Capability and absorptive capacity.

*Proceedings from the Innovation Metrics Review Workshop* is at Appendix D.

The infographic has five boxes (Consultation, Submissions, Origins of those consulted, Expert, and International workshop).
The Consultation box has an icon with five people corresponding to individuals that the Review consulted with. The Consultation box also has an icon with three people before a globe corresponding to organisations that the Review consulted with. The Innovation Metrics Review consulted 209 individuals from 94 organisations.
The Submissions box has an icon of a letter with a reply arrow corresponding to submissions that the Review received on the consultation paper released by the Review. The Review consulted with and received 36 submissions in response to its consultation paper.
The Origins of those consulted box has two superimposed bar charts (Organisations and Individuals) on the same axis showing the proportion of stakeholders consulted by the Review according to their origin (Private sector, Academia and research, Australian Government, State and Territory Government, International entity, General public). The graphs are ordered in descending proportion by organisation origin type. The superimposed graphs show that while more private sector organisations have been consulted than any other category, the biggest group of people consulted was the group from Australian Government entities. 
The expert box shows icons for experts from industry, academic and government. In total, 42 experts advised the Innovation Metrics Review on an ongoing basis. These experts participated as members of the Steering Committee, the Expert Reference Group, the various Innovation Metrics Review and Australian Academy of Technology and Engineering expert working groups and as international technical advisers.
The International workshop box shows that there were 51 experts in innovation measurement in attendance at the International Workshop.

### Sectoral studies were conducted to provide insights that might not be captured by current metrics

The Review undertook four sectoral studies to provide insights to the Review on:

* how innovative activities occur across different sectors of the Australian economy
* how current innovation measures are capturing (or not capturing) those innovation activities
* what is possible and practical in the measurement of innovation activities
* how measures might be improved to provide a more comprehensive picture of the relative innovation performance in all sectors of the Australian economy and assist policymakers to make evidence-based decisions.

The four sectors selected for sectoral studies were:

* mining
* agriculture
* health services
* finance and insurance services.

To ensure coverage of each sector and consideration of a diverse range of perspectives, the Review identified and consulted with a range of potential stakeholders. These included: small, medium and large businesses; peak bodies and industry-owned companies; statutory bodies; and academic institutions. The consultation process involved interviews that were conducted with individuals or in groups. In addition to the interviews, a range of information sources was consulted to provide further context and supplement the evidence provided by interviewees.

The sectoral studies are in Appendix B.

### ATSE conducted a literature review that provided context and learnings used by the Review

ATSE was commissioned to undertake a literature review as part of the Review. The literature review:

* provides context for the Review’s activities
* helps to relate the Review to authoritative sources
* looks at the innovation measurement frameworks being used by others
* describes the evolution of innovation thinking, changes in the nature of innovation and its increasing diversity
* looks at innovation beyond the business
* examines entrepreneurship
* looks at opportunities to improve the measurement of innovation.

The literature review is given in Appendix E.

ATSE also provided input into the conceptual framework used by the Review. More detail on the framework is given below.

## The Review adopted an Innovation Metrics Framework

The Review adopted an Innovation Metrics Framework (the Framework) that draws on key concepts and elements identified in the *ISA 2016 Performance Review*.[[10]](#footnote-11) The Framework has been deliberately developed at a broad level (Figure i.4). This allows the Framework to encompass the full range of activities and complexities that make up the innovation system (Table i.1).

Figure i.4: Innovation Metrics Framework

| The figure is a circle with two outer layers showing the framework components that the Innovation Metrics Review classified the Innovation system. At the centre is the impact of innovation. The next layer out shows Creation, Diffusion and Transfer, and Application. These are smudged together reflecting that these steps do not operate in a linear way in the modern innovation ecosystem. The outer layer comprises the International environment, the Domestic governance and institutional environment, Infrastructure, and the Business environment. |
| --- |

At its centre, the Framework focuses on the impact of innovation. The Review recognises the breadth of benefits that innovation delivers to society, but focused on the economic impacts of innovation (in particular productivity, investment, jobs and exports), as these are where innovation policy can have the greatest impact on living standards. Innovation has economic, environmental, social and governance-related impacts, but the Review has focused on the economic impacts.

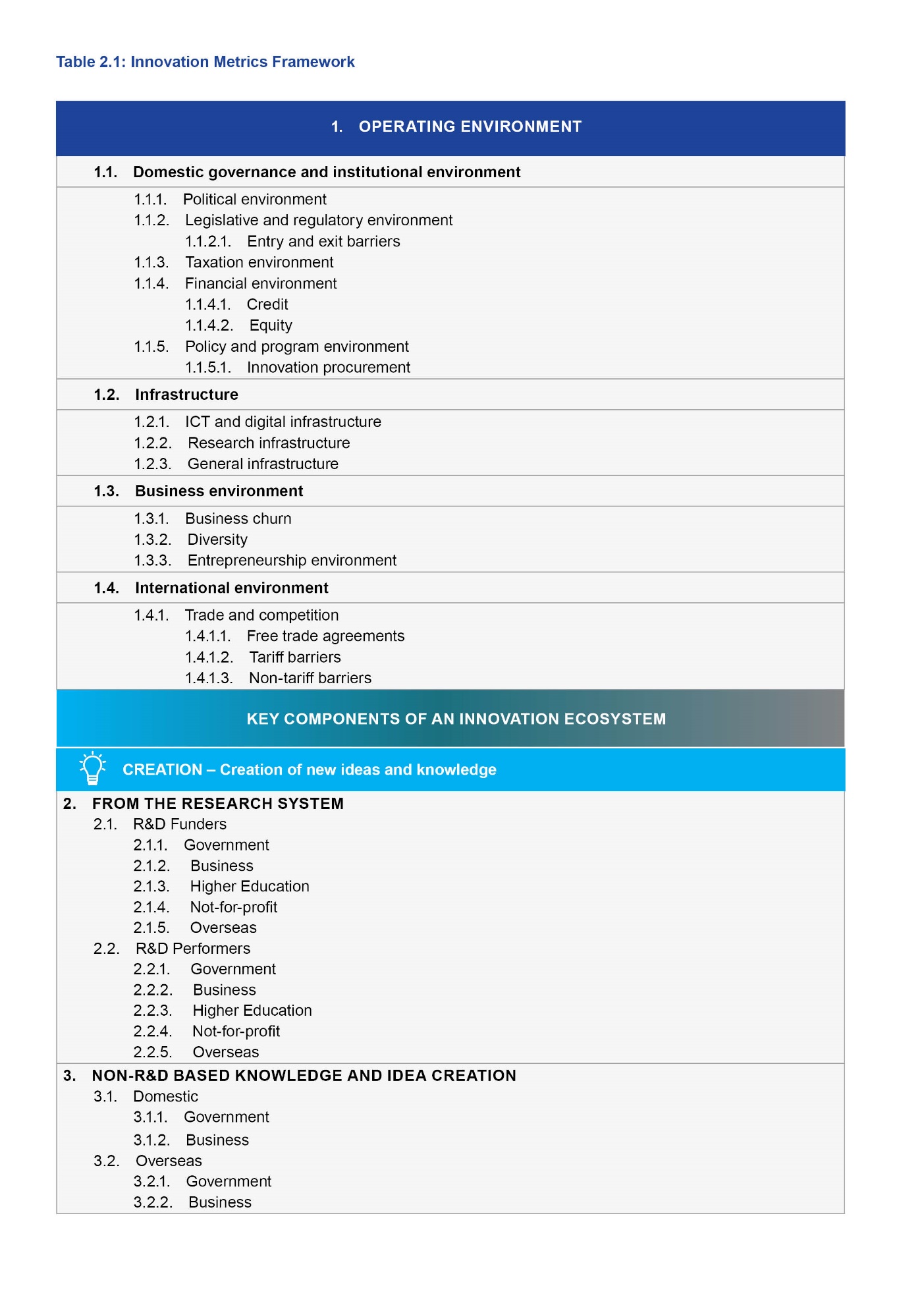
At the middle, the Framework identifies the key components that form an innovation ecosystem. These have been categorised under three headings, ‘creation’, ‘diffusion and transfer’ and ‘application’.

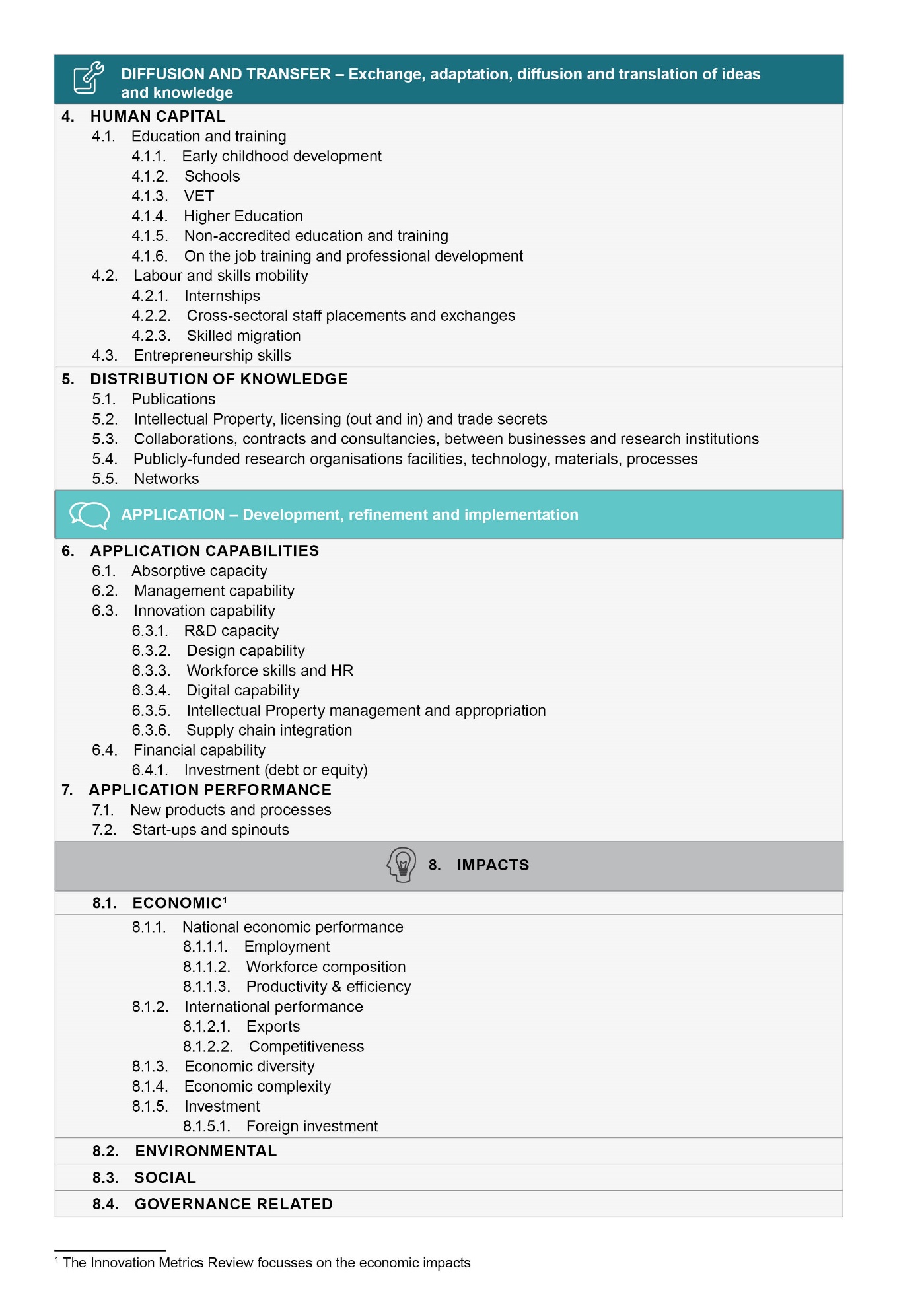
The creation, diffusion and transfer, and application components behave in a non-linear fashion.

* Creation refers to the creation of new ideas and knowledge. It acknowledges that innovation creation occurs across various stages and with various actors. For instance, both R&D and non-R&D based knowledge and idea creation are performed by government, businesses, higher education institutions, and not-for-profit organisations
* Diffusion and transfer refers to the exchange, adaptation, diffusion and translation of ideas and distribution of knowledge. This can occur through human capital training and spillovers, as well as more formal collaborative and information sharing arrangements
* Application refers to the development, refinement and implementation of innovation. Application capabilities and application performance depend on capabilities and capacities in the innovation system, such as management capability and access to skills and finance.

For the components of the innovation ecosystem to operate effectively, a well-functioning overarching operating environment needs to be in place (outer circle of the Framework). The operating environment broadly covers key areas, such as domestic governance and institutional environment; infrastructure and business environment; and the international environment.

The Framework was used by the Review to assess the components of the innovation system, for which there are either few or no innovation metrics available and fit for use. This was done by mapping available metrics against the components of the Framework as outlined below.

Table i.1: Innovation Metrics Framework



## The effectiveness of innovation metrics was determined using seven key principles and assessment criteria

The Innovation Metrics Framework is central to the identification of the full range of activities and complexities that make up the innovation ecosystem.

The Review obtained metrics from a wide range of sources – including the OECD, Eurostat, the Global Innovation Index (GII), the Global Competitiveness Report (GCR), the ISA scorecards, Australian Innovation System Report, and the ABS – and mapped the available metrics against the components of the Innovation Metrics Framework.

An innovation metrics assessment matrix was developed (see Table i.2) based on principles drawn from the *Oslo Manual 2018*.[[11]](#footnote-12) These included how fit for purpose the selected metrics are using the principles of relevance, accuracy and validity, reliability and precision, timeliness, coherence, comparability, accessibility, and clarity.

The assessment matrix allowed the Review to make a preliminary assessment of whether metrics were relevant to the Framework and fit for purpose. Metrics that had no issues identified with them that would affect their use were assessed as ‘green’. Those of limited use in relation to the Framework were assessed as ‘orange’. Those with significant limitations were assessed as ‘red’. Where metrics had issues based on some of the principles but not others, the worst colour code applicable to that metric was used.

This does not mean that all metrics assessed as ‘orange’ or ‘red’ are useless to policymakers. For example, metrics generated using data produced by the Programme for the International Assessment of Adult Competencies (PIAAC) were assessed as ‘red’ because PIAAC is administered every 10 years. Yet PIAAC data and metrics are regarded as very important for policy purposes. The long interval between PIAAC cycles does, however, mean that other metrics are required to supplement PIAAC metrics. Education accounts for a high proportion of Australian, state and territory expenditure and it would not be reasonable to evaluate performance in this area only every 10 years. Thus metrics generated by the Programme of International Student Assessment (PISA) are recommended for use when only old PIAAC data is available, as PISA data, while far more limited, is produced every three years and is therefore more useful for program evaluation.

Appendix F, ‘the Innovation Metrics Compendium’, has been provided to show where existing metrics map to components of the innovation ecosystem, including an assessment to identify the gaps in coverage in terms of either the number or the quality of metrics. The numbering system shown on Table i.1 corresponds with the structure of the Compendium.

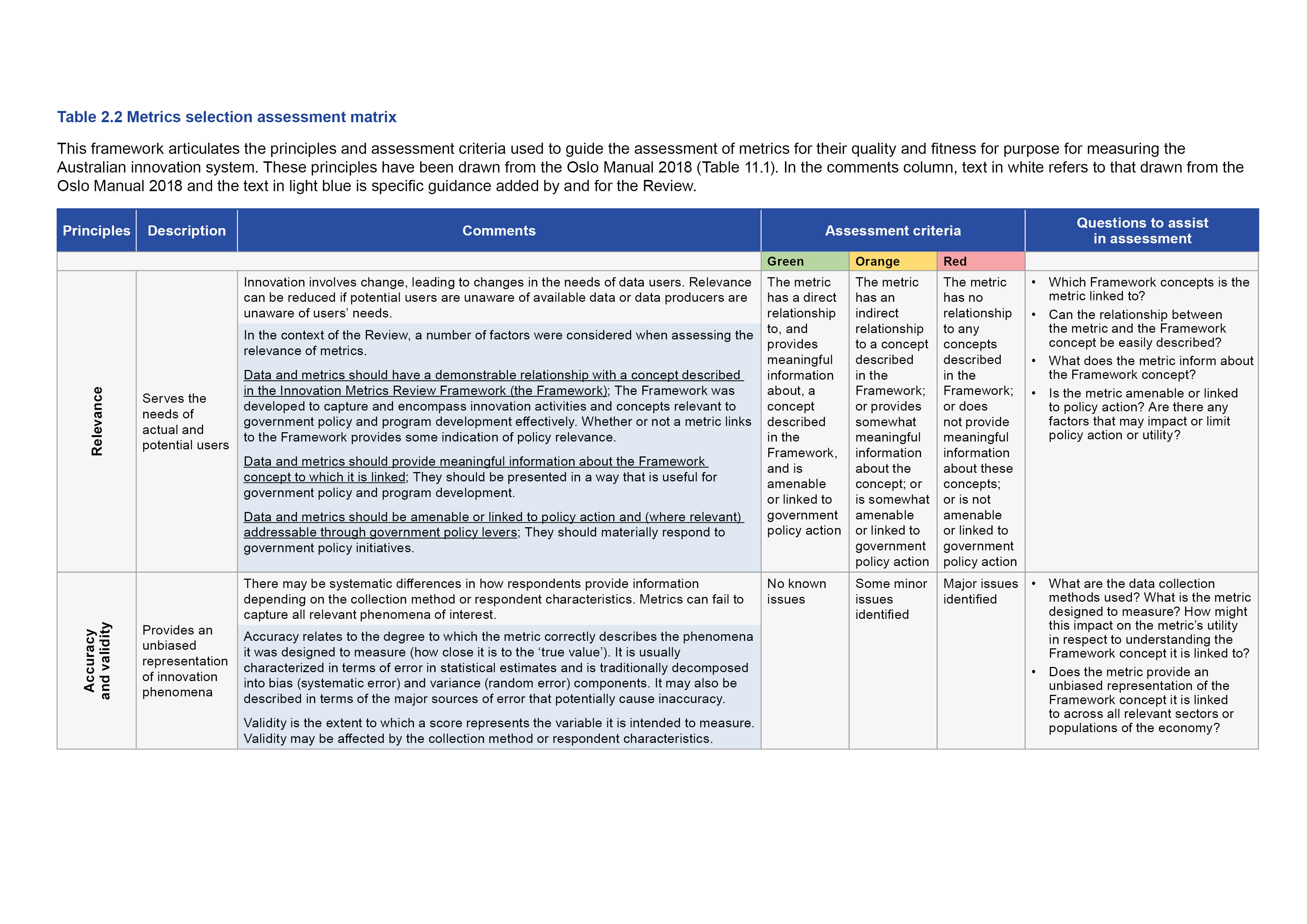
Figure i.5 provides an indication of the Review’s assessment of innovation metrics against the Framework components. Of the 597 metrics collected, 186 (31 percent) were rated as green, 302 (51 percent) were rated as orange, and 109 (18 percent) were rated as red. In the metrics assessed by the Review, gaps in innovation data exist in the non-R&D based knowledge and idea creation category, as well as in the application performance category. While the Review considered many metrics for the research system, most have been assessed as having issues associated with their use (orange or red), with around 10 percent of metrics having a green quality assessment.

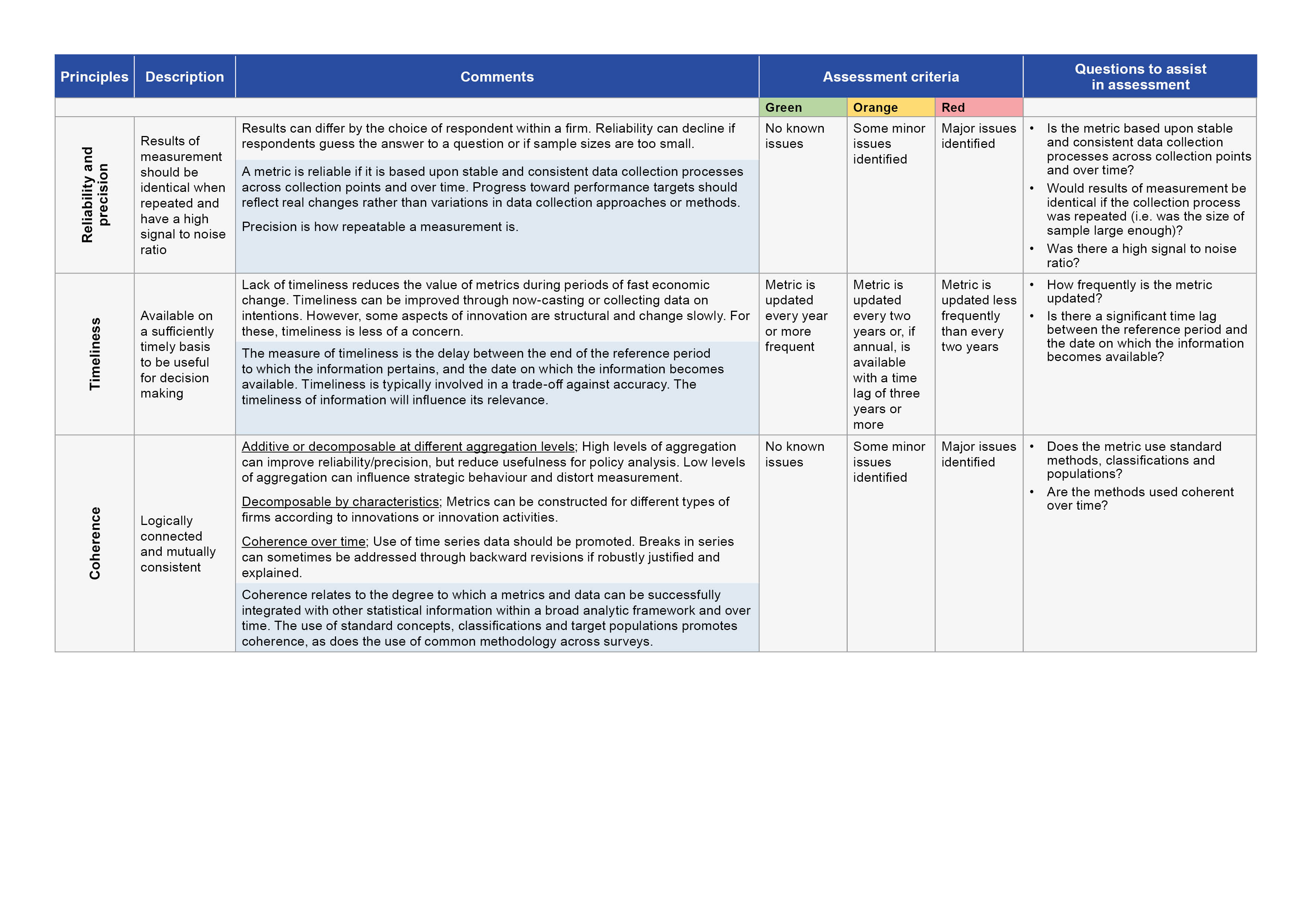
The assessment matrix also assisted the Review’s selection of innovation metrics for the development of an innovation metrics scorecard. Further detail on the development of the Scorecard is provided in Chapter 1.

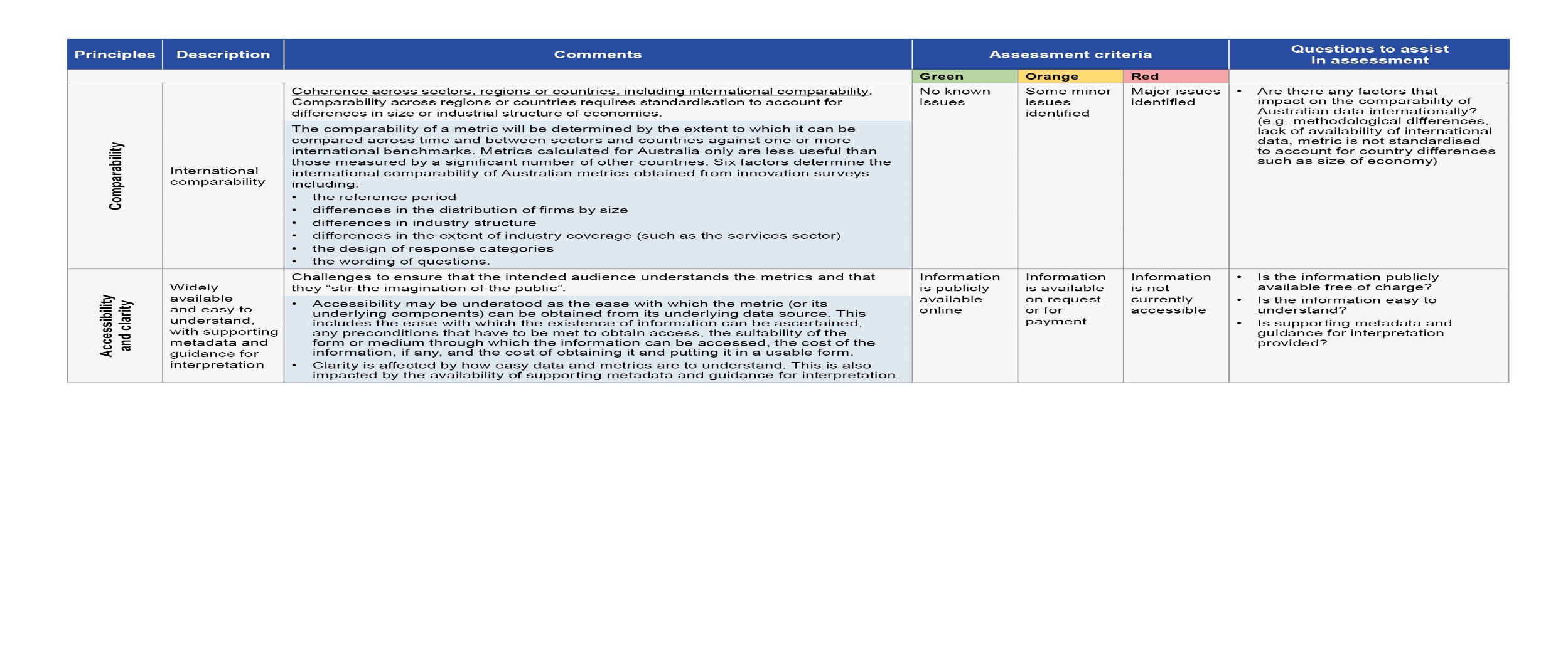
Figure i.5: Number of quality-assessed metrics within each Framework component

| The figure is a bar graph with the framework components (Operating environment, Research systems, Non-R&D based knowledge and idea creation, Human capital, Distribution of knowledge, Application capabilities, Application performance, Impacts) on the y-axis plotted against the number of metrics encountered by the Review on the x-axis. The bar graph is discussed in the report at pages xxxvii-xxxviii. The bar graph illustrates the lack of Non-R&D based knowledge and idea creation, Application capabilities, and Application performance metrics. |
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Table i.2: Metrics selection assessment matrix

This framework articulates the principles and assessment criteria used to guide the assessment of metrics for their quality and fitness for purpose for measuring the Australian innovation system. These principles have been drawn from the Oslo Manual 2018 (Table 11.1). In the comments column, the text in white refers to that drawn from the Oslo Manual 2018 and the text in the light blue box is specific guidance added by and for the Review.





# Measuring the performance of the Australian innovation system

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| Key points   * National innovation systems are complex and scorecards can provide an effective mechanism for quickly communicating the most significant aspects of innovation * Scorecards can underpin public discussion about where policymakers might usefully intervene * Research by the Productivity Commission shows that productivity growth is a key factor in determining a country’s standard of living. The Review has developed a Scorecard based upon the Productivity Growth Framework developed by the Productivity Commission * There is already a strong relationship between innovation, productivity growth and improved living standards. In developing the Scorecard, the Review therefore sought to align the measurement of innovation performance to where innovation policy can have the greatest impact on living standards * The Scorecard contains a handful of the most important indicators for monitoring innovation-driven productivity gains in the economy. The indicators are mapped against the drivers of productivity growth, given limitations on the data available to underpin them * The Review recommends that an Innovation Metrics Scorecard should be reported annually to Government and regularly reviewed. |

## Why is measuring the performance of the innovation system important?

### Innovation systems are complex and difficult to measure

National innovation systems are very large and complex entities, and are constantly changing. The innovation metrics framework discussed in the Review Process and Methodology section is central to the Review’s assessment of innovation metrics and their selection to measure the performance of an innovation system. The framework encompasses the full range of activities, actors and complexities that make up the innovation system.

Innovation is more than just the conception of a new idea, it requires implementation to realise its potential.[[12]](#footnote-13) Innovation systems are the network of actors that are collectively responsible for the creation, diffusion and implementation of these new ideas.[[13]](#footnote-14) The system is dynamic and actors come from diverse sectors and levels of the economy.

There are two main challenges in the study of innovation and innovation policy:

1. It must try to ‘measure how things that are themselves difficult to measure affect other things that are also difficult to measure’.[[14]](#footnote-15)
2. Innovation systems are dynamic and interconnected and ‘understanding the process, products and eventual impact of science and innovation activities requires the ability to observe and understand action at multiple levels of analysis’.[[15]](#footnote-16)

The measurement of the performance of innovation systems, and the selection of metrics to guide innovation policy, are therefore matters that require expert understanding and ongoing attention.

## What is the current status of Australia’s innovation performance measurement?

Due to the complexity of innovation systems, measuring innovation performance is often linked to models or organising frameworks. The selection of an appropriate organising framework is independently taken by authors based on various factors, including fitness for purpose. A subset of suitable metrics is then selected and grafted onto the organising framework.

There have been numerous previous analytical approaches taken to measure the performance of innovation systems in an economy. These innovation performance measures can be generally categorised in three areas:

* On one end are composite indices that combine multiple indicators to produce an overall ranking of a country’s innovation performance. Composite indices often include a call to action but provide no policy clarity, given the focus on an overall single score
* On the other end are dashboard monitors that provide comprehensive data about many aspects of an innovation system but are too detailed to provide simple insights to policymakers or other decision makers
* Somewhere between composite indices and dashboard monitors are scorecards, which provide a high-level brief overview of a country's innovation performance, focusing on a limited number of indicators where policy action can improve performance in a key area of national priority.

Prominent examples of these analytical approaches include the European Innovation Scoreboard (EIS), the GII, the OECD Science, Technology and Industry (STI) Scoreboard, the Australian Innovation System Monitor (AIS Monitor), and the ISA scorecards. These are outlined in more detail below.

### Australian Innovation System Report and Monitor

The Australian Innovation Systems Report (AISR) annual series (2010–2017) identifies three components: innovation activities, networks and framework conditions that collectively work as a system to generate and diffuse innovations that have economic, social or environmental value. The AIS assessed the performance of Australia’s innovation system by comparing identified indicators against other countries.

The AIS Monitor[[16]](#footnote-17) is a new flagship digital dashboard for tracking Australia’s innovation system performance, superceding the highly regarded AISR. The new mobile-ready web platform gives readers up-to-date information on business innovation, entrepreneurship, science and research, network and collaboration, and skills and capability. It maps the Australian innovation system through interactive charts, downloadable data and regular content updates. The AIS Monitor provides a comprehensive set of innovation indicators to inform the performance of an innovation system.

### Innovation and Science Australia Scorecards

The *Performance Review of the Australian innovation, science and research system 2016* (the 2016 ISA Review)[[17]](#footnote-18) assessed the performance of the innovation, science and research system using a simple framework to identify three innovation activities: knowledge creation, knowledge transfer, and knowledge application. The 2016 ISA Review included a scorecard that mapped a limited number of indicators against the performance framework of outcomes, outputs, and the innovation activities.

In 2017, ISA published the *Australia 2030 Prosperity through Innovation* plan (the ISA 2030 Plan),[[18]](#footnote-19) introducing a new scorecard that developed a common set of metrics to underpin performance reviews in the future to inform decisions about the most effective way to invest in Australia’s innovation, science and research system.

### The European Innovation Scoreboard

The EIS[[19]](#footnote-20) provides a comparative analysis of innovation performance in European countries and other countries, including Australia. It assesses relative strengths and weaknesses of national innovation systems and helps countries identify areas they need to address. These are discussed in the main report and summarised in an interactive tool, akin to a dashboard.

The scoreboard distinguishes between a summary indicator and four main indicator groups to provide a comparative assessment of innovation performance for its member states. These indicator groups include: framework conditions, investments, innovation activities, and impacts.

### The Global Innovation Index

The GII[[20]](#footnote-21) is a high profile international index that compares the performance of national innovation systems across economies.

The GII measures innovation based on a summary index score, supported by separate innovation input and output sub-indices including: institutions; human capital and research; infrastructure; market sophistication; business sophistication; knowledge & technology outputs; and creative outputs. These dimensions of innovation are then combined into a single score or composite indicator.

### OECD Science, Technology and Industry Scoreboard

The OECD STI Scoreboard[[21]](#footnote-22) draws on the latest comparable data, primarily from its Main Science and Technology Indicators (MSTI) as well as other innovation survey data. It provides insights that can help governments design more effective science, innovation and industry policies.

The OECD STI Scoreboard uses minimal composite indicators. Instead, it provides harmonised data for the purpose of international comparison and benchmarking against OECD averages to help users develop analysis based on their own interests.

## An Innovation Metrics Scorecard for Australia

### Purpose of a scorecard

Measuring the performance of the Australian innovation system and the ability to communicate quickly and effectively to a broad audience was a key issue raised during this Review. Previous attempts on measuring the performance of Australia’s innovation system and its reporting to date appear to have received limited use, except as point-in-time snapshots by the media and in briefings within Australian governments.

Constructing an insightful analysis of the performance of an innovation system is difficult because of gaps in the underlying data. However, there is merit in being able to provide a high-level overview of Australia’s innovation system performance that is meaningful to a broad audience. This overview could even be complementary with existing dashboard monitors that are suited to those who work professionally in innovation policy or the academic and research community.

Innovation performance scorecards can provide an effective mechanism for quickly communicating complex ideas, particularly to a broad, non-technical audience. In this context, scorecards may act as a useful conversation starter to underpin public discussion about where Australian governments can usefully intervene to address a key issue of national priority. Participants in the Innovation Metrics Review International Workshop echoed this, stating that a scorecard is essential for stimulating dialogue with the public and with policymakers. A scorecard also aids the development of new measures that reflect the quality – rather than just the quantity – of innovation.[[22]](#footnote-23)

An innovation metrics scorecard would provide an ongoing opportunity to raise the profile of innovation to Australian governments. Such a scorecard would play its most useful role if it was used consistently as part of annual messaging by the Australian Government in relation to its innovation system oriented policies. The intended audiences for a scorecard should be policymakers and analysts, industry stakeholders, and international organisations, e.g. the OECD. Consistent use of the scorecard would lead to it becoming recognised as a reliable tool for understanding the Australian national innovation system.

### Determining the most meaningful approach to develop a Scorecard

In the early stages of the Review, an overarching Innovation Metrics Framework (the Framework) was adopted and is discussed in detail in the Review Process and Methodology. It is important to be able to measure the performance of the different aspects of innovation captured in the Framework.

However, in determining the most meaningful approach to develop a scorecard, which of necessity can include only a handful of the most important indicators, the Review sought to establish a performance measurement system for innovation which is responsive to the unique characteristics of the Australian economy, and empowering to Australian policymakers, whilst also enabling comparison where possible to international peers.

The overarching aim in developing the Scorecard is to inform policies that can boost Australian productivity and living standards, not to be top of an international innovation metrics ranking table.

Innovation is not an end in itself. It is undertaken within businesses in order to lead to outcomes, such as improved sales and profits, and in the public sector to improve services to citizens and advice to government. In the aggregate, the sum of innovations undertaken results in improvements in economic growth and living standards. Living standards are broadly defined to be analogous to well-being or welfare.

The Review therefore focused on aligning the measurement of innovation performance to where innovation policy can have the greatest impact on living standards. The Scorecard thus follows the structure of the Productivity Growth Framework, established by the Productivity Commission to look at how the economy, business environment and business activities each build on each other and drive productivity growth, discussed later in this chapter.

### There is a strong relationship between innovation, productivity growth and improved living standards

The realisation of improved living standards through innovation and links to productivity growth provides a meaningful approach to guide the development of an innovation metrics scorecard for Australia.

According to the Australian Government’s current *Intergenerational Report*, there are three main factors that determine the quantity of goods and services (Gross Domestic Product) that a country produces: population, participation and [labour] productivity.[[23]](#footnote-24) These three factors are often referred to as the ‘3Ps’ framework to help explain the impact of government policies on economic growth over the long-term.

In the context of economic growth, the key component of population is considered to be the number of people over the age of 15 who may be available to work.

Participation is made up of three elements: how many people choose to seek work (the workforce participation rate), how many of them can get jobs when they do seek work (the employment rate) and the average number of hours worked by individuals who have jobs. Improvements in participation happen as more people choose to look for work, more of them are able to find work, and they are able to work more hours.

Productivity is a measure of how much is produced, on average, for every hour that is worked. Productivity is considered the most important driver for long-term economic and income growth, and an important factor in a country’s standard of living.

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| ‘Productivity isn’t everything, but in the long run it is almost everything’[[24]](#footnote-25)   * Paul Krugman |

An increase in productivity by one percentage point a year will double average living standards in 70 years; a two percentage point rise will achieve this level in 35 years; and three percentage point rise in 23 years.[[25]](#footnote-26) Productivity growth is therefore considered a key indicator of a country’s overall prosperity and is commonly used to benchmark international economic performance.

Innovation is a key source of productivity growth

Innovation can increase productivity through more efficient services and production processes, more effective workplace organisation, and by opening up new markets. 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.

According to the OECD, innovation in its various forms accounts for a substantial share of economic growth across its member countries – often around 50 percent of total GDP growth over the long-term.[[26]](#footnote-27) Innovation has also been reported as being the only way for most developed countries to secure sustainable long run productivity growth.[[27]](#footnote-28)

Innovation can drive productivity growth in a number of ways. Figure 1.1 shows how innovation activities can contribute to improvements in GDP. Changes over time in GDP per capita (productivity) are, at least over the long run, almost wholly accounted for by changes in GDP per hour worked; that is, by labour productivity and labour utilisation.

Labour productivity is defined as output per worker or per hour worked. Growth in labour productivity is comprised of two components: growth in capital inputs per worker (referred to as the contribution from ‘capital deepening’) and the contribution from multifactor productivity (MFP) growth.

Capital deepening reflects the increase in the ratio of capital to labour, and allows more to be produced in each hour worked. Capital services are comprised of physical capital formation, such as buildings, machinery, equipment and computers, and intangible capital such as R&D, computer software and databases, artistic creations, and business processes. Labour services are comprised of human capital (labour quality) elements, such as education attainment and experience of workers.

MFP is the residual that reflects pure productivity improvements, where changes in outputs cannot be explained by changes in inputs (labour and capital). It captures all other factors that influence outputs, including the efficiency in which the key inputs of labour and capital are used to produce goods and services.

It is reasonable to regard some share of capital deepening as attributable to innovation. For example, IP may be embodied in new equipment. In addition, the introduction of new capital goods and the use of new technologies can raise returns on investment, which encourages capital deepening.

Innovation also drives productivity growth by moving out the productivity frontier, or by enabling businesses to catch up to the productivity frontier. According to the OECD, higher R&D collaboration is associated with a faster catch-up process for laggard businesses very far from the national productivity frontier, and with businesses close to this frontier keeping pace with it.[[28]](#footnote-29) Process improvements, such as marketing and organisational innovation, improve business level productivity. The development of new final product innovation can improve productivity if it improves quality, or if the new products can be produced with fewer resources. New intermediate inputs can directly raise productivity.

Innovation can also lead to new ways to correct market failures by reallocating resources from lagging to leading businesses. The OECD analysis found that leading businesses are not only more productive than laggard businesses but they are also more capital and patent-intensive, have larger sales and are more profitable.[[29]](#footnote-30) Leading businesses can help markets to allocate resources to their best uses. Innovation can therefore also drive creative destruction and structural changes.

Labour utilisation is defined as the hours worked per person. An increase in hours worked per person means more goods and services can be produced.

Some growth in labour utilisation can be attributed to innovation through advances in health technology that result in increased life expectancy and workforce health. Technology advances also free up time from household tasks and allow more outsourcing of household tasks, facilitating increased formal labour supply.

Figure 1.1: How does innovation drive economic growth. Factors coloured green are influenced by innovation.

| The figure is a flow chart depicting the components of innovation that flow upwards into economic growth as depicted by Gross Domestic Product per person. The components of the diagram are discussed at pages 7-8 of the report. The flow chart uses colour to show the pervasive effects of innovation. |
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### A conceptual framework for drivers of productivity growth

The Productivity Commission has outlined a framework (Productivity Growth Framework) for conceptualising the main drivers of productivity growth.[[30]](#footnote-31),[[31]](#footnote-32)

The drivers or determinants of productivity growth comprise a mix of factors at the microeconomic level (business or individual), as well as broader macroeconomic conditions that reflect policy settings which can be affected by government. The Productivity Commission has identified the main drivers of productivity growth to include:

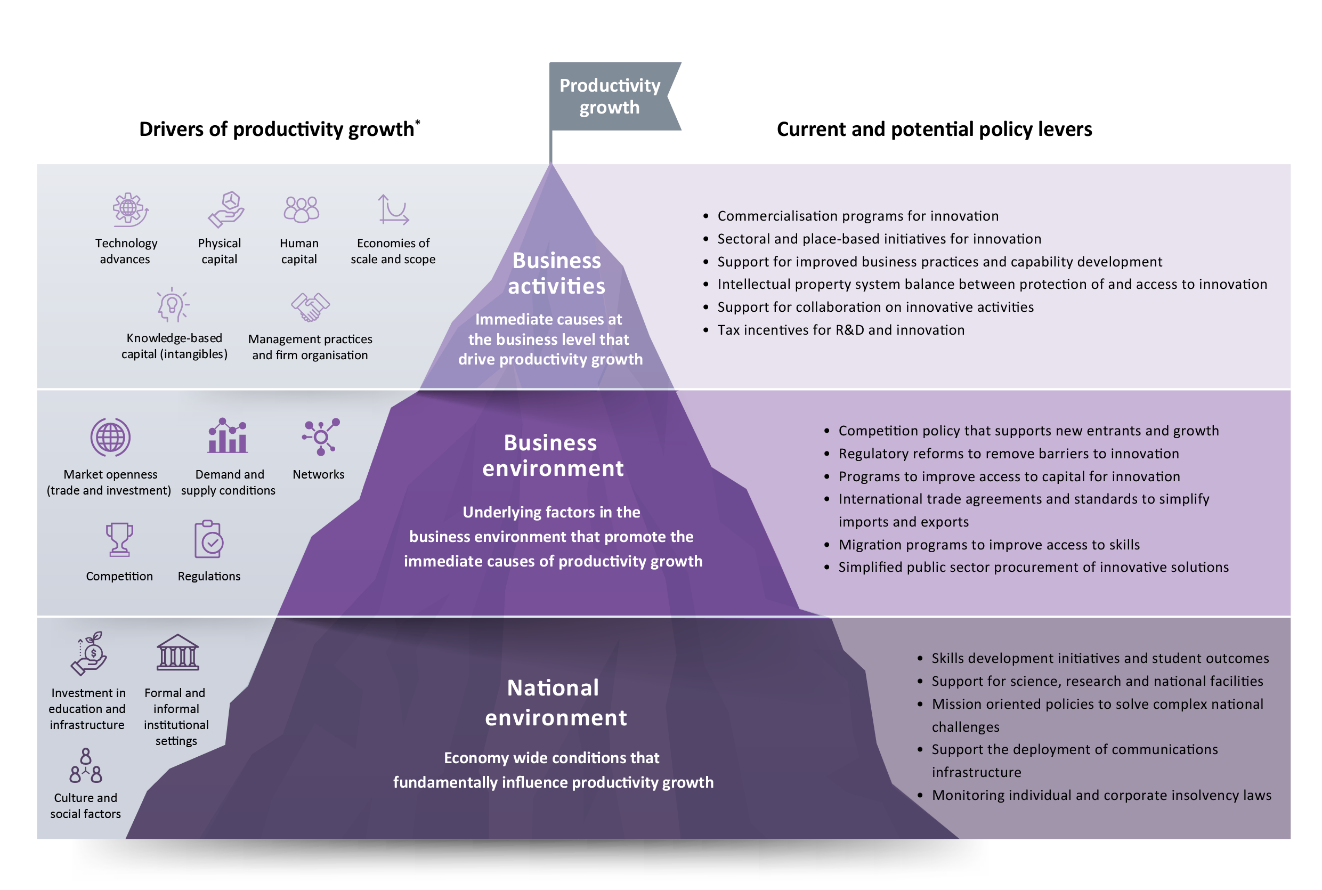
* *Immediate causes* (Business activities) that have close, tangible links to input/output relationships in production, often at the level of businesses or individuals. These are necessary to bring about productivity improvement but can be difficult to engender without policy changes at the macro level. Immediate causes of productivity change at the business level include:
  + Technological advances, such as better equipment that can enable better production techniques. Specialisation in production (economies of scale and scope) is also important in bringing about productivity improvements, for example, by allowing more efficient or new technologies to be adopted
  + Investment in physical and human capital, including knowledge-based capital, are seen as central and related in the development, application and refinement of innovation, which drives productivity improvements
  + Business organisational, management practices, and work arrangements, including organisational structures that enable collaboration, can be a major source of productivity improvement.
* *Underlying factors* (Business Environment) can have an indirect effect on productivity, as they can determine the extent to which the immediate causes of productivity growth come into play. These factors mainly include competition, openness of the economy to trade and investment, and demand and supply conditions. Appropriate levels of regulations are also an important factor. Regulations that are too burdensome can inhibit the adoption of different production methods and new technologies, whereas those that are too relaxed can fail to drive required changes. (In the finance and insurance services sector in particular, businesses reported a significant amount of innovation was being driven by regulatory charge.)
* *Fundamental influences* (National Environment) involve deeper policy, social and institutional factors that affect productivity in a very general and indirect fashion. They reflect the emphasis given by policymakers to different economic objectives that affect the development of productivity‑enhancing capabilities, such as investment in education and infrastructure. The stability of policy settings through formal and informal institutions can affect the risks involved in making long-term investment decisions. Cultural and social factors also shape the orientation of people towards change that is required to achieve further development. For example, risk appetite of the community will affect the rates of technology adoption of things like autonomous cars, drones and artificial intelligence (AI).

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| ‘Productivity is a major contributor to growth and prosperity over the long term’.[[32]](#footnote-33)   * Productivity Commission |

### Policy levers that drive productivity growth through innovation

The Review has presented the Productivity Commission’s Productivity Growth Framework for the ‘drivers of productivity growth’ as a mountain (Figure 1.2) to illustrate how innovation feeds into productivity improvements at the economy level. The Review has also conceptualised the relevant ‘current and potential policy levers’ that can foster improvements in economic prosperity via the innovation system in Australia.

Below productivity growth are the ‘business activities’ that have close, tangible links to input and output relationships in production. The ‘business environment’ is the next layer down of the mountain, having indirect effects on productivity. Performance at this level can determine the extent to which the business activities of productivity growth come into play. The base of the mountain is the ‘national environment’ that involves deeper policy, social and institutional factors that affect productivity. This relationship is very general and has indirect influence on each of the layers above it.

Figure 1.2: Productivity framework for innovation and policy levers to drive productivity growth through innovation

Notes: \* ‘Drivers of productivity growth’ as per the Productivity Commission report (2009), Australia’s Productivity Performance: Submission to the House of Representatives Standing Committee on Economics.

## The Scorecard tracks key innovation metrics that drive productivity growth

This Review focuses on the economic impacts of innovation. The Review, guided by the Scorecard Expert Working Group, mapped innovation metrics to the ‘drivers of productivity growth’. The Review adopted MPF growth rate as the ultimate measure of the impact of innovation due to its link with innovation. MFP growth rate is the growth in labour productivity not accounted for by capital deepening. It therefore represents improvement in the production process, or ‘innovation’, that is not an input into the production process.

It should be emphasised that measuring the environmental and social impacts of innovation are also high priorities – the Roadmap notes that further work is required in those areas to measure impact comprehensively.

The Scorecard (Figure 1.3) contains a handful of the most important indicators, based on the current data available, for monitoring innovation-driven productivity gains in the economy. The selected metrics for the Scorecard are also categorised as either innovation inputs or outputs to ensure impacts can be traced back to inputs in a method akin to evaluation using Program theory.[[33]](#footnote-34)

However, the metrics represented in the Scorecard are inadequate, due to gaps in data. The Review has proposed a number of recommendations to develop new data sources and metrics, which should, in turn, provide opportunities to improve the metrics included in future scorecards. For example, the development of metrics for identified productivity drivers that are not represented in the current Scorecard. There are also instances where more suitable metrics would be appropriate but the data to support them is not currently available.

Definitions and descriptions of the innovation metrics used in the Scorecard and their sources are found in Appendix H.

For each metric, data for Australia and other OECD countries have been sourced and presented where available. The average result for the top five countries in each year was used to benchmark Australia’s performance. The trend line shows Australia’s performance over time, along with how it compares with the top five countries over the same period. For the latest available data, Australia’s ranking amongst comparator countries has been compiled.

Australia’s percentile rank has been calculated and colour coded to match this ranking. A green rating indicated that Australia is ranked in the first quartile (top 25 percent) of countries. A yellow rating shows that Australia’s performance is in the second quartile (26–50 percent). A red rating shows that Australia is placed in the third or fourth quartile (51–100 percent) for performance.

Figure 1.3: The Innovation Metrics Scorecard

| The figure is the Innovation Metrics Review’s Scorecard. The scorecard is described in the text at page 13. |
| --- |

## The figure is a diagram showing the productivity framework for innovation and policy levers to drive productivity growth through innovation. The diagram is of a mountain and has been described in the text of the report at pages 10-11.Key insights from the Innovation Metrics Scorecard

### Business innovation activities

In terms of innovation inputs made by business, Australia’s performance has been in decline for the levels of business collaboration, investment in knowledge-based capital and expenditure on R&D. Of these metrics, Australia is ranked in the third or fourth quartile against comparator countries. Australia is ranked in the second quartile for total innovation expenditure which has stagnated. However, Australia is a leader in the business adoption of cloud computing, used here as a proxy for adoption of broader digital technologies tools.

Outputs of innovation for business are also stagnant. The proportion of businesses that have more than 25 percent revenue from sales is broadly steady, but the high growth enterprise rate and volume of IP rights filed overseas all rank Australia in the lower quartiles.

### Business environment

Australia ranks in the top quartile for the levels of regulatory barriers that businesses operate in. This has flowed through to business entries where Australia ranks highly with consistent entry rates. However, Australian start-ups have access to relatively low amounts of venture capital (VC) in comparison to the rest of the OECD (see Figure 1.3, Scorecard metric 10).

### National environment

Australia has a healthy mix of the foundational elements to support innovation. Australia ranks in the top quartile for educational investment. The level of investment has remained steady throughout the period. Despite this investment, the translation of this expenditure into educational outcomes is weak. The performance of students in mathematics – considered a key discipline for innovative capability – has been in gradual decline, with Australia recently ranked in the bottom quartile. Additionally, Australia’s proportion of the population aged 25–34 with tertiary qualifications ranks in the second quartile of countries. In contrast, the quality adjusted labour input of Australians, which considers both the qualifications and experience of the workforce, is tracking well (top quartile).

However, there are issues to be addressed with infrastructure development for innovation where Australia ranks in the bottom quartile for the quality and quantity of broadband subscriptions in the population. There has also been a recent decline in investment in R&D by the economy as a whole (GERD). According to a recent analysis by AlphaBeta, the mining cycle and structural change in the Australian economy account for most of the decline in BERD, which is a significant proportion of GERD.[[34]](#footnote-35)

### Productivity growth has been positive but subdued in recent times

Australia’s performance in business activities is concerning, while the national environment and business environment for innovation show areas that need specific attention. There are many opportunities for improvement. Australia has experienced nearly a decade of slowed productivity growth, as measured through MFP change, from the year 2000. This trend has mirrored declines across the top comparator countries. Australia has since been able to arrest that decline, but recent MFP growth rates are well below the rates achieved in the period 1993–99.[[35]](#footnote-36) Innovation-led productivity improvements will be key to ensuring continued long-term economic and income growth.

Box 1.1: Multifactor Productivity (MFP)

| **Measuring productivity**  The measurement of productivity in itself, and particularly MFP, has three main measurement challenges:   1. Outputs in the non-market industries, such as public administration, education and health, are difficult to measure. Therefore, MFP is only based upon 16 market industries. 2. There is a lag in estimates because businesses struggle to adjust inputs to increases or decreases in demand. This results in reduced productivity in down years, and vice versa. 3. Some inputs, such as natural resources and intangible capital, are not measured well and may be excluded. This can distort MFP when there are changes in these inputs and outputs. |
| --- |

Source: Reserve Bank of Australia, 2019, [Productivity](https://www.rba.gov.au/education/resources/explainers/productivity.html), viewed 18 December 2019, <https://www.rba.gov.au/education/resources/explainers/productivity.html>

## Future reviews and updates of the Scorecard will ensure it remains current and relevant

Given the dynamic and evolving nature of the innovation system and its components, and to take advantage of new sources of data, it is recommended that the Review’s Scorecard be adopted and published online annually.

DIIS’ *AIS Monitor* will continue to provide a comprehensive list of relevant innovation metrics for the Australian economy and should form the foundation for the development of the Scorecard moving forward. The *AIS Monitor* will focus on high-quality metrics from reputable sources with expert commentary and analysis. It also includes some exciting new features to improve the publication's utility, including interactive charts, downloadable datasets converted to a machine-readable format, and links to complementary analytical work.

This Review recommends that the Scorecard be periodically reviewed at intervals of around three years, commencing in the second half of 2022. The periodic review of the Scorecard should be conducted to:

* review the approach and methodology to reflect current priorities
* identify new data sources and metrics
* review and update the metrics as new sources of data becomes available.

| **RECOMMENDATION 1.1: INTRODUCE ANNUAL INNOVATION SYSTEM REPORTING** |
| --- |
| The Review recommends that an appropriate entity responsible for innovation measurement in Australia should produce an innovation metrics scorecard and provide a report to the Australian Government annually.  Every year the responsible entity should provide:   * a publicly available report on the performance of the innovation ecosystem in Australia * an innovation metrics scorecard that measures progress domestically and benchmarks Australia’s performance internationally.   The Scorecard developed by the Review should be adopted until improved innovation data becomes available (a minor update for some of the metrics will be needed in the second half of 2021).  Future periodic reviews should be undertaken from the second half of 2022, to inform the approach for developing an updated scorecard. |

The following is a summary of scorecard metrics, relevant to the drivers of productivity, for future consideration by the entity responsible for innovation measurement.

### Business activities

* Investigate the inclusion of an output metric on national frontier firms to understand the proportion of Australian businesses that are the most productive business in an international context (global frontier firms)
* Investigate the inclusion of an input metric relating to the management capabilities of businesses, such as the monitoring of key performance indicators and use of strategic planning in business decision making – this will depend upon whether underpinning data can be sourced at that time
* Investigate the inclusion of an input metric based on labour force skills, such as the proportion of the workforce that are innovation active, based on their occupation type – relevant work is currently being undertaken by the Department of Employment, Skills, Family and Small Business, but is yet to be completed

### Business environment

* Investigate the inclusion of an input metric based on the government’s procurement of innovation. As a major procurer of goods and services, this metric will show how the government is fostering innovative businesses. This metric will depend upon whether underpinning data can be sourced. The Review recommends action to ensure that it is sourced (in Chapter 2)
* Investigate the inclusion of an input metric based on innovation networks. ‘Networks’ is a very broad term. In this context, it is envisioned that networks be limited to a business’s place in a supply chain, i.e. its suppliers, its customers, and related businesses that are co-located.

### National environment

* When available, investigate the temporary substitution of the education output measurement from PISA to PIAAC to get a broader coverage of skills proficiency in the working age population. As PIAAC data are collected every 10 years, substitution between the metrics should be explored
* Investigate the adjustment of the input metric on broadband infrastructure subscription to address future technology developments in mobile and fixed broadband speed tiers.

# Data and metrics for measuring innovation

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| Key points   * Across the innovation system, data are used in policy and program formation and evaluation. * There exists a variety of data sources but not all data are fit-for-purpose, particularly to inform policy decisions. Data quality is affected by the way in which data are collected and produced. * The data landscape is evolving. Increased digitalisation is providing more opportunities to source innovation data. * There are gaps in the information required to support analysis and understanding of the innovation system and to inform policy decisions. Key areas of data gaps include: * **areas of the innovation system where the concepts and measures in place are fit-for-purpose, but there are gaps related to the frequency, granularity or availability of current data** * **areas where there is a sound conceptual basis for measurement, but measurement challenges impact data utility** * **areas where there are conceptual and measurement challenges.** * Many of the information gaps and emerging data needs highlighted by the Review are not unique to Australia. * Addressing the information gaps and emerging data needs will require statistical, analytical and research solutions to be investigated and developed. * Non-government data and new big data analytic techniques represent emerging opportunities to understand Australia’s innovation landscape and to improve measurement of its performance. |

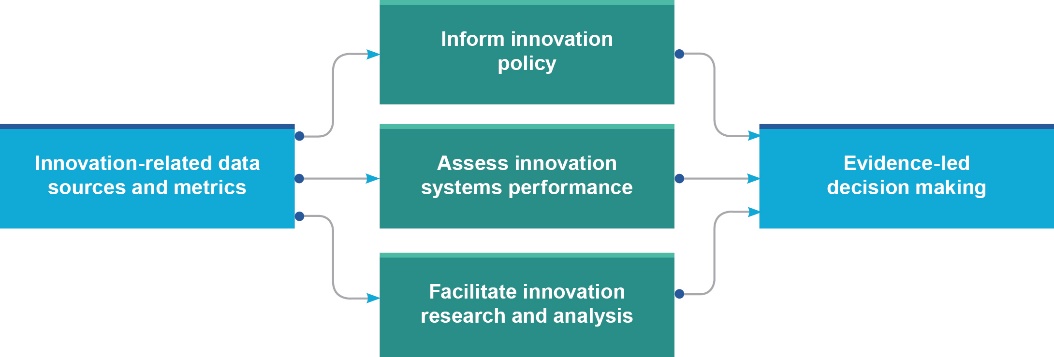
## How data and metrics are used

A large amount of data and metrics exists across the innovation system that is relevant to innovation measurement and is heavily used in policy and program development, implementation and evaluation. Similarly, there is a large amount of analysis occurring to support evaluation of the innovation system.

As shown in Figure 2.1, innovation-related metrics and underlying data sources support evidence-based decision making by:

* informing innovation policy – good quality data are essential for Government to inform innovation-relevant policy advice, program delivery, service implementation and decision-making
* assessing innovation system performance – metrics enable policymakers to assess innovation system performance (refer Chapter 1 for detail on scorecards). Benchmarking and assessing innovation performance over time, industries and sectors, regions and countries provides valuable insight into the effectiveness of policies and the identification of factors that contribute to desirable innovation outputs and outcomes
* facilitating innovation research and analysis – fit for purpose data sources and metrics across all relevant areas of the innovation system is necessary to address the needs of users. Innovation analysis and research identifies linkages across, within and between various innovation activities, and provide insights on enablers of innovation activities. The analysis of data also indicates whether those data are fit for purpose and what data are the most useful to inform policymaking. Analysis is discussed further in Chapter 3.

Figure 2.1: How innovation-related data sources support evidence-based decision making



## Sources of data and metrics

### Assessing fitness for purpose

Assessing data sources for their suitability is an important first step in determining key innovation metrics that matter for government decision making.

The Review developed a set of principles for metrics selection (Table i.2) to assess the fitness for purpose of existing innovation data sources and metrics in the context of their ability to inform policy, assess innovation performance and facilitate innovation analysis and research for the phenomena of interest.

### Types of data sources

The types of data sources examined by the Review (Table 2.1) are classified as being ‘government’ or ‘non-government’, and ‘structured’ or ‘unstructured’. Survey data and administrative and transactional data are both structured, and are entered into relational databases for easier analysis. Unstructured data needs to be analysed using Big Data techniques (e.g. Facebook and Twitter data).

Table 2.1: Types of data

|  | Survey data (structured data) | Administrative and transactional data (structured data) | Unstructured data |
| --- | --- | --- | --- |
| Government data | Government survey data (e.g. ABS surveys, such as the Business Characteristics Survey, Research and Experimental Development Survey, and the Census) | Administration and transaction data (e.g. Australian Taxation Office and government programs data) | Government data not entered into a relational database (e.g. official emails) |
| Non-government data | Non-government survey data (e.g. that produced by Newspoll) | Private sector data (e.g. that produced by LinkedIn, Seek, Burning Glass and Xero)  Commercial databases (e.g. Orbis and Clarivate) | Non-government data not entered into a relational database (e.g. web scraping data collected by Burning Glass and Faethm) |

### Structured Data

**Survey instruments**

Survey instruments have long been a tool for research, marketing and official statistics. They can be administered online, by paper form, phone or face-to-face.

Surveys are used to collect information in order to answer a question or make a decision. They are also used to put a value onto some indicator or measure. In general, they are used when there are no other data sources available that can produce the required information. Careful survey design is required to provide quality indicators. This includes determining the population of interest, designing a representative sample and collection vehicle (i.e. questionnaire) through to quality assuring and disseminating results. Their key limitation is that respondents must be willing and able to answer the questions asked for them to produce quality data.

Surveys measure one or more characteristics of a population. These characteristics may be measured by surveying all members of the population, or a sample of the population. A sample survey is a survey of a subset of the population.[[36]](#footnote-37)

The Australian Government currently uses national questionnaire-based surveys to produce data on innovation. Information is provided by survey respondents via a questionnaire aimed at collecting a specific set of data from a particular group of respondents (e.g. people or businesses).

**Assessment of advantages (✓) and disadvantages (🗶) of surveys**

| Relevance | ✓ Surveys can be tailored to find out particular information of interest that may not be available through other sources |
| --- | --- |
| Accuracy and validity | ✓ Surveys can be used to collect data from a target population of interest, e.g. businesses, people, and provide high representativeness  🗶 Surveys can return responses of varying quality. Quality can depend upon respondents’ interpretation of the question, or the availability of information. Survey questions must be designed to accommodate all respondents within the population of interest. |
| Reliability and precision | ✓ Due to high representativeness, surveys are able to provide statistically significant results  ✓ Surveys may obtain a high response rate if administered by government, particularly by the ABS, whose surveys can be made mandatory  🗶 Some surveys may obtain a low response rate for various reasons, e.g. difficulties in establishing contact with participants, or respondents not appreciating the value of contributing. This may result in low representativeness of the data |
| Timeliness | 🗶 Surveys take time to administer and process. This impacts on the timeliness of results |
| Coherence and comparability | ✓ Surveys are able to use standardised concepts and definitions to deliver coherent and comparable results over time and between sectors, regions and countries |
| Accessibility and clarity | ✓ Depending on who is administering the survey, results are usually accessible with supporting explanatory materials containing methodology |
| Cost | 🗶 Surveys impose a burden on respondents as well as on the collecting entity. |

**Administrative and transactional data**

Administrative and transactional data are collected as a by-product of administrative processes or trade, usually during the delivery of a service.[[37]](#footnote-38) Prominent examples of government administrative data sources relevant to innovation include tax, business registrations, education, government program and grant application records.

Administrative data are becoming increasingly important in providing information to Australian governments, as access is unlocked and data are integrated and analysed. However, the value of government administrative data collections is yet to be fully realised. Access to datasets is a key issue for many inside and outside of government, including universities and researchers. This is partly due to the complex web of regulation across government agencies, as highlighted by the Productivity Commission’s Inquiry Report, *Data Availability and* Use (May, 2017).[[38]](#footnote-39)

There are an increasing number of private sector organisations that are realising the potential value to government of their structured data collections, and many have approached government looking to commercialise or otherwise provide their data sources. For example, Clarivate Analytics has a long history of providing data products to government on a fee-for-service basis –Clarivate’s Web of Science citation databases are used and linked with data in Orbis to produce data about research publications produced by businesses.

Other private sector organisations, such as LinkedIn, offer analyses for public good purposes to government pro-bono. Non-monetary incentives for private sector organisations entering into such agreements with government include building their profiles and social licences to operate.

Box 2.1: Government administrative data has the potential to provide valuable information, but is often inaccessible

| Government innovation programs could potentially provide valuable data on the innovation system. These data are often of high quality as they are associated with funding allocation. Additionally, because the data already exists and are owned by government, they could potentially be made available quickly at low cost. The data are usually not available online, even when their public accessibility is not restricted in other ways (e.g. by the *Privacy Act 1988*).  In early 2016, the Productivity Commission was tasked to undertake a benefit cost analysis of options for increasing the availability and improving the use of public and private sector data by individuals and organisations. The Productivity Commission identified a ‘lack of trust by both data custodians and users in existing data access processes and protections, and numerous hurdles to sharing and releasing data are choking the use and value of Australia's data’, and recommended ‘the creation of a data sharing and release structure that indicates to all data custodians a strong and clear cultural shift towards better data use that can be dialled up for the sharing or release of higher-risk datasets.’[[39]](#footnote-40);[[40]](#footnote-41)  The Australian Government subsequently published its response to the Productivity Commission Inquiry into *Data Availability and Use*, agreeing to the majority of the proposed reforms.[[41]](#footnote-42)  At the time of publication of this Review, the Australian Government had initiated reforms to increase data access and use within government and also with trusted users outside of government, while improving data privacy and security with strengthened, consistent safeguards. The Australian Government has:   * established a National Data Commissioner to implement and oversee a simpler, more efficient data sharing and release framework * introduced legislation to improve the sharing, use and reuse of public sector data while maintaining the strong security and privacy protections the community expects * introduced a Consumer Data Right to allow consumers to share their transaction, usage and product data with service competitors and comparison services * established a new National Data Advisory Council to advise the National Data Commissioner on ethical data use, technical best practice, and industry and international developments. |
| --- |

**Assessment of advantages (✓) and disadvantages (🗶) of administrative and transactional data**

| Relevance | 🗶 Administrative and transactional data are often collected for a specific purpose that may not align with the needs of users |
| --- | --- |
| Timeliness | 🗶 The timeliness of administrative and transactional data is usually better than that for surveys, but can still vary considerably from near real-time to quite dated (e.g. tax records are typically submitted well after a reporting period has ended) |
| Accessibility and clarity | 🗶 Administrative and transaction datasets are not usually publicly accessible and are in general not available to all, even within the entity that collected them. Often, only the entity that collected them will have access to any metadata and there may not be any documented guidance to assist interpretation.  🗶 Private sector datasets are not generally accessible to government, though businesses may choose to make them available through Memoranda of Understanding, sometimes, but not always, for a fee. It is usually the analytical products that are made available, sometimes, but not always, for a fee.  Client consent may be required before data are shared. The private sector organisation is dependent on their user agreement. |
| Accuracy and validity | 🗶 Administrative and transactional data are often collected for a specific purpose. Making data available for research is usually a secondary consideration. The data may need cleaning before it is useable and may not be fit for certain purposes.  🗶 Data may only be available for certain groups within a population, or coverage may be variable (such that data has low representativeness due to bias) |
| Reliability and precision | ? The precision of datasets used to allocate public funding is often high, but that of others may vary  🗶 Administrative datasets may be unreliable over time. They are usually collected to support a specific program or group of programs. Data collection processes may change radically or cease in response to changes to the underpinning government program, causing a series break or sudden absence of data  ✓ Can provide large sample size for analysis  🗶 Administrative data are usually only available for small groups within a population (i.e. service or grant recipients) and thus may not be representative of the population  🗶 Transactional data often reflects the customer base of the collecting entity and may not be representative of the population  🗶 Analyses are only as good as the data they are based on |
| Coherence and comparability | 🗶 As administrative and transactional data are by-products, collection procedures are likely to have been developed without reference to an internationally agreed measurement framework, definitions, concepts, classifications and target population may change over time following amendments to program criteria or changes to business objectives. Transaction data are usually only collected while a good or service is being provided, which may result in an incomplete time-series for analysis. |
| Costs | ✓ There are no additional data collection costs as data has already been collected |

### Unstructured data

The data landscape is changing. Digitalisation and the internet has opened up new sources of data and novel ways of extracting this data. Unstructured data sources are increasingly being utilised for a variety of purposes, including the production of official statistics.

**Big Data**

‘Big Data is commonly understood as the use of large scale computing power and technologically advanced software in order to collect, process and analyse data characterised by large volume, velocity, variety and value.’[[42]](#footnote-43)

Interest in using Big Data has been largely driven by the rise of web-based platforms, digital technologies and increasing data storage capacity. These factors have hugely expanded the sources of available data and the variety of information that can be collected. Big Data can enable entities to learn about client age, gender, location, household composition, demographic profile, dietary habits, and even their personal biometrics.[[43]](#footnote-44)

There are many organisations that provide Big Data analytics for a fee. For example, The Conversation is an international media organisation that provides a platform for scholarly communication that enables researchers to engage a global public audience with operations around the globe. Their unique database of researchers, readers, and media content enables production of new types of research engagement metrics, including media-influence metrics, and post-publication engagement metrics.

Public-private partnerships are also becoming more common, such as in Denmark, with the pioneering Danish Centre for Big Data Analytics Driven Innovation, launched by the Innovation Fund Denmark. This example of public-private partnership involves the computer science departments of three major universities, several IT companies with Big Data competencies, and public authorities.[[44]](#footnote-45)

The *2017 Tracking Trends in Industry Demand for Australia’s Advanced Research Workforce report* – a DIIS-funded collaboration between the Australian National University, CSIRO’s Data61 and SEEK – is an Australian example of a public-private partnership.[[45]](#footnote-46) This project involved the use of machine learning and natural language processing to analyse job advertisements in order to better understand Australian industry demand for highly skilled researchers.[[46]](#footnote-47)

**Web scraping and text mining**

Web scraping is the term used for extracting or downloading data from websites. Web scraping tools are required to perform these functions.

‘Web mining, the application of data mining techniques to uncover relevant data characteristics and relationships (e.g. data patterns, trends, correlations) from unstructured web data, has been shown to be applicable in many fields of research’.[[47]](#footnote-48)

Web scraping is also affected by the way websites are coded. Some businesses are increasingly designing their websites in a manner which makes web scraping harder.

The internet and increased data storage capacity have also given rise to large volumes of qualitative data. Text mining can be used to quantify this data. Text mining is a methodology that uses natural language-processing tools to automate the processing of text data (e.g. from responses to open-ended survey questions, large qualitative datasets and social media posts) into quantifiable data.[[48]](#footnote-49)

The University of New England (UNE) has a particular interest in understanding agricultural technology innovation using text mining. The UNE work involves looking at keywords (by year and frequency) within patent datasets to reveal major players that UNE might consider partnering with. Thus it can help UNE to align its own research capability with emerging areas in industry, both domestically and overseas.

**Assessment of advantages (✓) and disadvantages (🗶) of unstructured data**

| Relevance | ✓ May be able to provide new insights and illuminate parts of the innovation ecosystem where the government is currently lacking data to inform policy decisions |
| --- | --- |
| Reliability and precision | ✓ A large amount of data are available, providing coverage of a wide range of issues  🗶 Noise to signal ratio may be very high |
| Accuracy and validity | 🗶 Data quality, particularly representativeness of the data, may limit its use |
| Timeliness | ✓ Data can be analysed in close to real-time data, allowing timely program and policy evaluation |
| Coherence and comparability | 🗶 Data may not necessarily be logically connected, or consistent over time or across sectors, regions or countries |
| Accessibility and clarity | 🗶 Businesses do not usually put all their data into the public domain  🗶 There may be privacy and security concerns that limit data accessibility or cause data to become inaccessible over time. |
| Cost | ✓ Data are already being collected, so there are no additional collection costs |

## Sources of data and metrics currently available

Appendix I provides a summary of the key innovation-related sources of data and metrics currently being used by Government, highlighting where there are opportunities to make changes to increase existing utility.

## There are gaps in the measurement of innovation

To facilitate evidence-based decision making, users need innovation data sources and metrics to inform them about all relevant areas of the innovation system.

The Review’s Framework (described in the Review Process and Methodology) was used to assess the coverage of measurement of the innovation system by identifying:

* activities occurring within the framework that should be measured
* the current state of measurement for these activities
* gaps in the current measurement that lead to innovation activity being underestimated
* deficiencies in the current measurement and how they might be addressed.

The mapping of metrics to the Framework identified gaps in the information required to support analysis and understanding of the innovation system and to inform policy decisions.

The literature review of innovation measurement undertaken by ATSE identified a clear demand for a range of new or improved innovation indicators. ATSE notes there are several reasons for the gaps observed in available innovation indicators including:

* the need for a better evidence base to support new policy issues and decisions
* existing indicators failing to keep up with new understanding about the nature of innovation
* the contribution that new indicators can make to improved learning
* the lack of coordination between actors involved in the innovation ecosystem.

The literature review also identified indicator gaps around innovation outputs and impacts, knowledge generation and flows, technological opportunity, entrepreneurship and capability (see Table 10 in Appendix E of the literature review). There are also gaps around the role of demand, culture and support measures. Specific gaps in Australian innovation indicators also arise from issues such as Australia’s reliance on mining and agriculture, and the absence of large technology businesses.

Box 2.3: Global Innovation Index 2019 gaps

| In line with the findings of this Review, the importance of quality data that underpins innovation metrics was highlighted in the 2019 edition of the GII. Globally there have been improvements in innovation metrics, however, there are still gains to be made in areas such as the state of entrepreneurship, the availability of VC, the nature of innovation linkages and the commercialisation of innovation.[[49]](#footnote-50)  WIPO noted the steps that economies, including Australia, through this Review are making to improve the measurement of innovation. WIPO is active in helping policy and statistical offices monitor the state of innovation metrics through the provision of economy profiles. WIPO has highlighted Australian innovation data gaps that directly affect metrics of the GII. Due to the importance of internationally recognised innovation measurement frameworks, weight has been given to these findings, and they in turn have been utilised to inform the Review’s own findings.  The Review notes that Australian GII gaps have primarily centred on the availability of timely R&D data, and has informed the Review’s own finding on the state of R&D data. Other noteworthy gaps relate to apparent miscommunication of data availability. This gap serves to illustrate the need for better coordination on innovation data sources to ensure the most up to date innovation data are published or available. |
| --- |

The Review has identified various information gaps that can be grouped as follows:

* **Areas of the innovation system where concepts and measures in place are fit for purpose, but where there are gaps related to the frequency or availability of current data**

These are areas of the innovation system where there are opportunities to improve the utility of current data. Policymakers have some level of information to aid with evidence-based decision making, but the utility of current data could be improved if it were produced more frequently, i.e. for timelier data, or presented in a different way.

* **Areas where there are sound conceptual grounds for measurement, but where measurement challenges reduce data utility**

These are areas of the innovation system where work has been done, either domestically or internationally, to develop conceptual frameworks for measurement. However, there are measurement challenges recognised domestically or internationally that negatively impact data quality.

* **Areas where there are conceptual and measurement challenges**

These are areas of the innovation system that require significant work to be undertaken to define and develop conceptual frameworks and also address complex measurement issues, before meaningful indicators or metrics can be developed. For the most part, these conceptual and measurement issues are not limited to the Australian context and are acknowledged internationally as problematic. Policymakers have very limited or no information to aid with evidence-based decision making.

## Gaps where the concepts and measures are in place and fit for purpose, but data needs are not being met

### Measures of Expenditure on Research and Experimental Development

**Why this is important**

More than one-third of the Australian Government’s $9.6 billion support for science, research and innovation in 2018–19 occurred through the R&D Tax Incentive (RDTI) program. Measures of BERD allow the Government to assess the effectiveness of the RDTI program.

Expenditure data on R&D across all sectors of the economy (GERD) and businesses (BERD) are commonly used by governments and international organisations as metrics to compare countries’ innovation systems. This data allows Government to:

* inform policy briefings and analysis
* adjust policies and programs in response to trends in innovation and R&D
* undertake and evaluate new policy development.

**What information do policymakers need?**

Access to annual indicators of total expenditure on R&D across all sectors (GERD) and businesses (BERD) would allow policymakers to be responsive in adjusting policies and programs related to R&D in a timely manner.

In addition, more granular information on the Field of Research (FoR) and Socioeconomic Objective (SEO), would enable policy analysts to align the strategic research priorities of the publicly funded research sector with business direction and track research and innovation in sectors that are considered strategic priorities for the country.

Collecting BERD data annually would enable the ABS to model GERD data annually.

***Current state of play***

Australian data on R&D expenditure is collected and published every two years on asynchronous collection between sectors (business, higher education, government and private non-profit institutions (NPIs). Internationally, most NSOs collect and publish annual R&D expenditure statistics across all sectors.

In addition, the time lag between the reporting reference period and publication of some R&D estimates for business (BERD) and higher education expenditure on research and development (HERD) is currently 15 months. Under current circumstances, policymakers may have to make decisions based on data that is up to four years old.

**Future outcomes sought**

Based on consultation with users of R&D expenditure information, the Review recommends changes that will allow policymakers to access timely indicators of R&D expenditure. Specifically, the Review recommends that the ABS’ Survey of Research and Experimental Expenditure:

* is administered annually
* uses a sample size that enables FoR and Socio-Economic Objective data to be published at the four digit level (the second level of the Australian and New Zealand Standard Research Classification hierarchy, providing more granularity in relation to field and purpose of research)

| **RECOMMENDATION 2.1: IMPROVE MEASURES OF EXPENDITURE ON R&D** |
| --- |
| The ABS should produce annual indicators of Gross Expenditure on Research and Development (GERD) and Businesses Expenditure on Research and Development (BERD), including estimates of R&D expenditure at a more granular level than is currently available. |

### Measuring business use of digital technologies

**Why this is important**

The ongoing diffusion of new digital technologies across the economy is one of the key enablers of business innovation. However, measurement tools do not sufficiently capture the extent of their adoption, use, benefits, or role they play in innovation. Emerging technologies include a selection of digital technology tools that are considered important for innovation, such as AI, the Internet of Things, global positioning technology, Big Data analytics, robotics and 3D-printing.

Additionally, digital infrastructure that is currently well measured is evolving, and adjustments that reflect demand are needed, e.g. measurement of the quality of mobile broadband technologies and fixed broadband infrastructure.

**What information do policymakers need?**

Access to timely, high-quality and reliable statistics that reflect the contemporary and dynamic nature of the role digital technologies plays in innovation to inform decision making by government, industry and individuals.

Measures that capture the extent and impacts of business adoption and use of digital technologies.

**Current state of play**

Current ABS survey content related to business digital technologies usage covers a limited scope of digital technologies. There is opportunity to review and update the content to reflect technological advancements.

Internationally, a significant amount of work is being progressed to develop measures that provide policy guidance and analysis related to digital activities, such as the OECD’s *Going Digital* project.[[50]](#footnote-51) There may be scope for Australia to leverage off this work to improve current scope and measurement of digital activities.

New sources of data, such as from web scraping, data integration, use of Big Data analytics, and data from the private sector, may have potential to improve the frequency and quality of data available on business adoption and the use of digital technology.

**Future outcomes sought**

The Review recommends that the Australian Government:

* update current measures of business usage of digital technologies to reflect new digital technologies used
* work collaboratively with international organisations to contribute to the body of knowledge related to digital activity and develop measures that are internationally comparable
* develop measures to quantify the lag between a new technology becoming available and being adopted – an indication of how fast Australia is adopting new technologies.

| **RECOMMENDATION 2.2: IMPROVE MEASURES OF BUSINESS USE OF DIGITAL TECHNOLOGIES** |
| --- |
| The ABS should update current survey content related to business use of digital technologies to reflect new technological advancements, and measure the extent of technology diffusion and its impact on business performance  The ABS should also leverage work being done internationally that measures the link between the diffusion of these new technologies and their impact on innovation  The responsible entity should investigate the feasibility of accessing and using alternative sources of data (e.g. Big Data analytics, administrative and transactional data) to provide new and complementary indicators of the extent of business adoption and use of digital technologies. |

## Gaps where there is a sound conceptual basis for measurement but measurement challenges impact data utility

### International comparability of business innovation indicators

**Why this is important**

Australia currently contributes data to two key OECD publications that compare a range of business innovation indicators across countries and across time – the STI Scoreboard and the MSTI.

Indicators of innovation in Australian businesses are important to researchers and policymakers in building an understanding of the drivers and impacts of innovation and understanding how Australian rates of innovation compare internationally.

**What information do policymakers need?**

Policymakers need to be able to make meaningful comparisons of Australian and international estimates of business innovation to evaluate Australia’s relative innovation performance.

**Current state of play**

Australia collects business innovation indicators through the ABS’ BCS. The BCS collects core indicators of innovation annually, with more detailed content on innovation collected every two years.

Australian and international measures of business innovation activities are developed using statistical concepts and underlying methodology defined by the Oslo Manual.[[51]](#footnote-52) However, direct comparisons between Australia and other countries are difficult to undertake because of a number of factors, including different reference periods, scope, response rates, and survey frequency.

Methodological challenges related to international comparisons have been highlighted in work by the ABS.[[52]](#footnote-53) The ABS developed an experimental methodology that used BCS data collected for a single reference year to estimate the proportion of Australian businesses that were innovation-active over a three-year reference period. This work was valuable but was not able to address all survey differences and provide directly comparable indicators.

The most notable difference is that Australian business innovation data are currently collected using a single financial year reference period, whilst innovation surveys in most other countries use a two or three-year reference period. This makes it difficult to compare international scorecards and rankings in a meaningful way, as the results presented are not like-for-like. If all else is equal, countries with longer reference periods are more likely to have higher rankings than those with shorter ones.

A one-year reference period, however, may also not be an ideal timeframe for measurement of innovative activities, i.e. in the 2016–17 reference year, approximately 25 percent of businesses reported that it was too early to measure the benefits of introduced innovation. This finding was confirmed in consultations undertaken to inform the Review’s sectoral case studies – only the finance and insurance services sector was generally able to measure impacts of an innovation in a one-year period.

However, moving to a three-year reference period, as used by most countries at present, is also not ideal. A –longer time period time impacts on respondents’ ability to recall and provide quality information. This was evident in cognitive testing conducted by the ABS and Statistics Canada during the Review’s consultation process.

The OECD has indicated that the use of a common observation period would considerably improve international comparability.[[53]](#footnote-54) The Review supports the OECD’s position. The Review notes that Statistics New Zealand (Stats NZ) currently has a two-year reference period, and its Business Operations Survey is administered two yearly, and Statistics Canada is also considering moving its Survey of Innovation and Business Strategy from a three to a two-year reference period.

In addition to the differences in reference period used, most international business innovation surveys are standalone innovation collections, whereas Australia collects business innovation indicators through the BCS – a large omnibus collection. Other topics collected on the survey relate to business characteristics and business use of information technology (BUIT).

A number of potential benefits have been identified with moving innovation survey content from a larger omnibus collection to a standalone innovation survey. These include:

* increased opportunity to change or add innovation question content in response to policy needs. The current length of the BCS limits the scope to make changes due to the anticipated effect on respondent burden and response rate
* increasing opportunity to produce more detailed outputs related to innovation and BUIT, and the relationships between them
* increased harmonisation of innovation survey methodology between Australia and the rest of the world
* over the life of the BCS, the innovation estimates have been described as having a ‘saw-tooth pattern’. This pattern is shown in Figure 2.2. Historical results show that in a BUIT-focused year, a greater proportion of businesses report being innovation-active compared to an innovation-focused year, where they are required to answer questions about the drivers, barriers and costs of innovation. By introducing a standalone innovation survey, the collection instrument will no longer be a potential driver of change in innovation estimates.

**Future outcomes sought**

The Review recommends a standalone Australian innovation collection, administered every two years using a two-year reference period, alternating with a two-yearly standalone business use of digital technologies survey, would be preferable to the current annual BCS. These changes would lead to:

* increased harmonisation of business innovation measures internationally
* more meaningful international comparisons of business innovation indicators
* more detailed outputs related to innovation and business use of digital technologies and the relationships between them
* more flexibility to change or add innovation question content in response to policy needs.

Figure 2.2: Innovation activity in Australian businesses, 2006–07 to 2016–17

| The figure is a line graph showing the proportion of innovation-active businesses from 2006-07 to 2016-17. The graph shows a pattern described as a “saw-tooth” (up down up down, like the edge of a saw blade) for reasons discussed in the report at page 34. |
| --- |

Source: ABS 8166.0 [Summary of IT use and Innovation](http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/8166.0), <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/8166.0>

| **RECOMMENDATION 2.3: IMPROVE MEASURES OF BUSINESS INNOVATION ACTIVITIES** |
| --- |
| The ABS should review the collection of business innovation data and make sure it aligns better with that of other countries so that direct comparisons can be made.  The ABS should ensure any changes made continue to meet the needs of other users of the data and are useful in the context of the Australian economy. In particular the ABS should:   * introduce a standalone Australian business innovation survey, administered every two years using a two-year reference period, to enable more meaningful international comparisons to be made. This survey would be mandatory, as is the practice with other ABS business surveys. |

### Expenditure on non-R&D innovation

**Why this is important**

There has been increasing demand to have meaningful measures of business innovation-related expenditure that go beyond expenditure on R&D.

Measures of innovation have focused largely on expenditure on R&D. However, the Review’s sectoral case studies reveal that R&D accounts for only a proportion of ‘all innovation-related activities’.

The level of expenditure on ‘all innovation-related activities’ by businesses provides useful information to policymakers on the scale of investment that businesses are making into innovation and the types of activities they are investing in. This information provides an evidence base for policymakers to determine whether or where interventions are needed.

If non-R&D innovation investment can be better quantified, it will assist with informing decision for policymakers.

**What information do policymakers need?**

Indicators of business expenditure on innovation, including and excluding BERD.

Information to support policy analysts to determine the relative importance of investments in various innovation activities, for example, R&D vs non-R&D investment.

**Current state of play**

While the Oslo Manual[[54]](#footnote-55) provides a clear framework for the measurement of innovation expenditure, collecting relevant information from businesses is problematic because innovation activities are not a line accounting item and therefore are not easily separated from other business activities.

In Australia, estimates (in expenditure ranges) of innovation expenditure that are collected through the BCS are of limited utility – collecting data that would support the production of a value estimate instead of a range would be preferable from a user perspective.

**Future outcomes sought**

Provide policymakers with an improved evidence base for understanding business expenditure on innovation-related activities.

| **RECOMMENDATION 2.3: IMPROVE MEASURES OF BUSINESS INNOVATION ACTIVITIES** |
| --- |
| The ABS should review the collection of business innovation data and make sure it aligns better with that of other countries so that direct comparisons can be made.  The ABS should ensure any changes made continue to meet the needs of other users of the data and are useful in the context of the Australian economy. In particular the ABS should:   * investigate ways to increase the utility and meaningful measurement and analysis of total business innovation expenditure. |

### Collaboration

**Why this is important**

Networking and collaboration are fundamental to any innovation system as businesses rarely innovate in isolation. With innovation recognised as a complex and uncertain activity, collaboration allows businesses to share risk, resources and ideas for innovation. These arrangements can allow businesses to increase the scale and scope of their activities and speed up the innovation process.

There is a strong government policy focus on business collaboration for the purpose of innovation, particularly with universities and higher education institutes, government agencies, and other research bodies.

**What information do policymakers need?**

Policymakers need to understand the extent to which businesses are collaborating with each other and other entities for the purpose of innovation, including the types of collaborative arrangements used and the collaboration partners.

**Current state of play**

The Review notes that in 2018 the OECD clarified its guidance regarding the definition of collaboration. The ‘collaboration’ indicator published by the OECD in the STI Scoreboard for Australia is of concern to a number of stakeholders who have expressed that Australia’s relative ranking with other OECD members does not reflect their experiences.

Current indicators of business collaboration for the purpose of innovation (collected through the BCS) exclude fee-for-service arrangements. This is in accordance with the international framework and definitions.[[55]](#footnote-56) The Review’s sectoral case studies found evidence that arrangements with some collaborative characteristics such as risk and IP sharing were either conducted predominantly on a fee-for-service basis, or else remained entirely informal, with no contractual arrangements in place. Examination of this issue is needed to determine if this is a minor or significant issue in the Australian context. Such arrangements should be reported separately, so that Australia is still able to report in accordance with the Oslo Manual.

**Future outcomes sought**

Provide policymakers with a more complete picture of the extent to which businesses are working together for the purpose of innovation, including the types of arrangements used and their partners.

| **RECOMMENDATION 2.3: IMPROVE MEASURES OF BUSINESS INNOVATION ACTIVITIES** |
| --- |
| The ABS should review the collection of business innovation data and make sure it aligns better with that of other countries so that direct comparisons can be made.  The ABS should ensure any changes made continue to meet the needs of other users of the data and are useful in the context of the Australian economy. In particular the ABS should:   * investigate the feasibility of developing broader measures of how businesses work together for the purpose of innovation, including fee-for-service arrangements. |

### Understanding business innovation measures in the context of economic contribution

**Why this is important**

There is interest in understanding businesses innovation activities in the context of the relative reach or impact of those activities on the broader economy. Since a larger business is likely to have a larger economic contribution relative to a smaller business, it would be useful for policy makers to have an understanding of innovation activities in the context of the size of the businesses undertaking them. A recent study on external benefits of R&D shows that the average business in the whole economy benefits more from external R&D from large businesses than from SMEs or very large businesses.[[56]](#footnote-57)

**What information do policymakers need?**

Policymakers need measures that complement existing indicators and enable policymakers to understand business innovation activities in the context of the relative economic contribution of business undertaking these activities.

**Current state of play**

Current measures of business innovation activities used internationally use the business as a unit of measurement in the production of aggregate estimates of innovation activity.

Aggregate estimates of innovative activity in business are therefore provided as a proportion of all businesses, which allows policymakers to understand the extent to which businesses are engaging in innovative activities, but not in the context of the relative economic contribution of the businesses engaged in the activities.

Existing indicators may be complemented with business innovation measures that use employment size or turnover as a proxy to weight businesses based on their likely economic contribution.

This would provide a more comprehensive picture of innovative activities in Australian businesses, enabling policymakers to understand business innovation activities better in the context of the relative economic contribution of innovation-active businesses.

| **RECOMMENDATION 2.3: IMPROVE MEASURES OF BUSINESS INNOVATION ACTIVITIES** |
| --- |
| The ABS should review the collection of business innovation data and make sure it aligns better with that of other countries so that direct comparisons can be made.  The ABS should ensure any changes made continue to meet the needs of other users of the data and are useful in the context of the Australian economy. In particular the ABS should:   * provide a more complete picture of the impacts of innovation activities occurring in Australian businesses. |

### Hidden innovation

**Why this is important**

The term ‘hidden innovation’ is used to refer to types of innovation or innovation activity that are not visible through innovation indicators.

The complex nature of the innovation system and activities that occur within it pose significant challenges for measurement. A number of factors make it difficult to achieve complete coverage of the activities occurring, including:

* the innovation system is extremely complex and activities are diverse
* innovation activities occur in different ways across different parts of the economy
* some aspects of the innovation system are difficult to measure, both conceptually and statistically, and in a way that is useful for government policy and program development.

**What information do policymakers need?**

An innovation measurement framework that provide comprehensive coverage of the diverse innovation activities occurring across different sectors of the Australian economy.

**Current state of play**

The concept of innovation covered in the Oslo Manual[[57]](#footnote-58) definition is very broad. Businesses can apply their own lens to questions asked in surveys, which can result in the information collected being different from the information that the survey question was designed to collect.

Interviews conducted as part of the Review’s sectoral case studies found that ABS R&D survey data are very reliable. However, the interviews indicated systemic under reporting of all non-R&D innovation activities, particularly with regard to continuous improvement. The R&D and non-R&D components of innovation expenditure were reported in 2017-18 and 2016-17 respectively as being similar in size. It is thus possible that expenditure on non-R&D innovation activity may be more significant in size than expenditure on R&D innovation activity. AlphaBeta notes that nationally, more businesses engage in non-R&D innovation expenditure than R&D innovation expenditure.[[58]](#footnote-59)

Apart from continuous improvement, which was under reported in the four sectors examined, the nature of under reporting varied by sector. This may be because businesses consider the continuous improvement activities as business as usual and not as “new or significantly improved” products or processes. For example, in mining, de-risking activity was generally not reported as innovation, whereas in agriculture, extension was generally not reported as innovation.

Experimentation may be required to improve measurement of non-R&D innovation activities. Differences between sectors make it challenging to capture everything in a whole of economy survey. The Review notes that there has been a lot of research to highlight hidden innovation but relatively little on developing appropriate solutions.

**Future outcomes sought**

* A comprehensive innovation measurement framework that provides comprehensive coverage of the innovation activities occurring, including better data on cost savings, economic benefits and productivity improvements resulting from innovation
* Contribute to the international body of knowledge related to innovation measurement.

| **RECOMMENDATION 2.4: CONDUCT AN ANNUAL SECTORAL ANALYSIS** |
| --- |
| The responsible entity should commission an annual large-scale sectoral study to develop a better understanding of the nature of innovation in those sectors that are important to the Australian economy. This study should:   * draw comparisons with a selection of countries that are relevant to the sector being analysed (e.g. for the mining sector, comparator countries should include those with major mining activity) * start with a sector that is important to the Australian economy and rotate annually to a different sector. |

### Existing occupation classifications do not reflect current practice

**Why this is important**

The ANZSCO is a joint product of the ABS and Stats NZ, and provides the basis for the standardised collection, analysis and dissemination of economic data on an occupation basis.

ANZSCO provides an integrated framework for storing, organising and reporting occupation-related information. The nature of the labour market is rapidly changing. New and emerging occupations are expected to continue to expand and have increasing importance, particularly in the areas of: information technology; the green economy; the digital economy; and skilled agriculture, construction, and disability occupations.

**What information do policymakers need?**

Policymakers require an occupation classification system that allows policymakers to understand innovation in the modern economy. For example, determining those employed in innovation-related positions allows a better understanding of the absorptive capacity of business.

There is also a requirement to identify new and emerging occupations in the economy and better inform policymakers targeting new jobs. Consultations have indicated that understanding talent flow is of policy relevance because governments are frequently concerned with whether there is sufficient talent flow to meet the needs of the Australian economy, and if not, how to attract it.

**Current state of play**

Stakeholders have expressed concern that ANZSCO does not reflect the rapidly changing nature of labour market occupations and how this impacts the economy. ANZSCO was last updated in 2013.

The International Standard Classification of Occupations (ISCO) was last updated in December 2007, does not meet Australian and New Zealand needs, and there is no realistic prospect of having this updated in a manner likely to meet Australian and New Zealand needs in the foreseeable future. This means that if Australia and New Zealand want a usable occupation classification system, they will have to update ANZSCO.

***Future outcomes sought***

* Improved ability to understand innovation in the modern economy
* Support informed policy decisions and government programs reliant on contemporary Australian skills and occupation information
* Improved ability to identify new and emerging occupations in the economy and inform policymakers targeting new jobs better
* Facilitate analysis and insight into new and emerging industries, skills and occupations that reflect the economic activities in the modern economy.

| **RECOMMENDATION 2.5: UPDATE OCCUPATION CLASSIFICATION SYSTEM** |
| --- |
| * The ABS should review and update the Australian and New Zealand Standard Classification of Occupations (ANZSCO) for new and emerging occupations that are expected to have increasing importance. |

### Existing industry classification does not reflect changes in the modern economy

**Why this is important**

The ANZSIC is a joint product of the ABS and Stats NZ, and provides the basis for the standardised collection, analysis and dissemination of economic data on an industry basis within Australia and internationally. ANZSIC is also is used to classify businesses in the collection and dissemination of innovation and R&D statistics.

ANZSIC is widely used by government agencies, industry organisations and researchers for policy, administrative, regulatory, taxation and research purposes. Such information is vital for policy development, as there are marked differences between industry sectors in terms of how they innovate, the role that R&D plays in their innovation activities, and their capacity to export, amongst other things.

**What information do policymakers need?**

An industrial classification system that allows policymakers to understand innovation in the modern economy.

The ability to identify new and emerging industries in the economy and better inform policymakers targeting new industries.

**Current state of play**

Stakeholders have expressed concern that the current industry classification, published in 2006, does not reflect changes that have occurred in the economy over the last decade, and that the lack of an update makes it difficult to understand innovation in the modern economy.

Conducting reviews of major statistical classifications is resource and time intensive, requiring additional funding to develop and implement, as they underpin all key economic and social statistics’ time series, including the Australian National Accounts, the Australian Population Census and the Labour Force.

It would be better to do this internationally and regularly, rather than just Australia and New Zealand as a one-off review. However, stakeholders have emphasized the need for a timely update.

**Future outcomes sought**

* To support informed economic and micro-economic industry policy decisions, better contemporary Australian industry information is required
* To ensure the industrial classification system reflects the modern economy and facilitates analysis
* To provide policymakers with insight into new and emerging industries
* To ensure that industrial classification activities are periodically reviewed to reflect the emerging economic activities in the modern economy
* Australia and New Zealand, as the co-owners of the Australia New Zealand Standard Industry Classifications, potentially to align this with the ISIC.

| **RECOMMENDATION 2.6: UPDATE INDUSTRY CLASSIFICATION SYSTEM** |
| --- |
| The ABS should continue to engage with the United Nations Statistical Commission regarding the International Standard Industrial Classification (ISIC), with a view to influence any update to:   * better reflect the Australian economic structure * facilitate meaningful sector analysis * aid evidence-based decision-making.   The ABS should continue to engage with the United Nations Statistical Commission and the Organisation for Economic Cooperation and Development to influence the development of a more streamlined and flexible way of conducting updates of industry classifications.  The ABS should review and update the Australian and New Zealand Standard Industrial Classification (ANZSIC) after the 2021 Census. |

### Existing research classifications do not reflect current practice

**Why this is important**

The 2008 Australian and New Zealand Standard Research Classification (ANZSRC) was developed to meet the dual needs for a comprehensive description of today's research environment, as well as the ability to compare R&D statistics internationally.

The ANZSRC is the collective name for a set of three related classifications developed for use in the measurement and analysis of R&D) undertaken in Australia and New Zealand.

There are three classifications in the ANZSRC:

* Type of Activity (TOA)
* Fields of Research (FoR)
* Socio-economic Objective (SEO).

The use of the three constituent classifications in the ANZSRC ensures that R&D statistics collected are useful to governments, educational institutions, international organisations, scientific, professional or business organisations, business enterprises, community groups, and private individuals in Australia and New Zealand.

**What information do policymakers need?**

Research classifications that reflect current practice and, capture emerging areas of research and remain responsive to change in the research sector

**Current state of play**

The ARC, ABS, Stats NZ, and the New Zealand Ministry of Business, Innovation and Employment (MBIE) are currently undertaking a joint Review of the ANZSRC to ensure that research classifications reflect current practice and remain responsive to change in the sector.

**Future outcomes sought**

* Research classifications are updated to reflect current practice and international comparability
* Research classifications that remain responsive to change in the research sector.

**Options to be considered**

Not required. Review of ANZSRC is already underway.

### Measuring innovation related to diversity

**Why this is important**

Diversity information is vital to inform policy development and facilitate business utilisation of potentially underutilised resources. Various forms of diversity, such as gender, ethnicity, age, sexual orientation, disability, and types of experience may impact on economic outcomes. Hsieh et al (2019) reports that an eight percent of growth in US GDP per person and 56 percent of growth in US labour force participation between 1960 and 2010 was explained by reduced labour market discrimination.[[59]](#footnote-60) The Grattan Institute has estimated that an extra six percent of women in the workforce could add up to $25 billion to Australia’s GDP.[[60]](#footnote-61)

**What information do policymakers need?**

High priority data requirements related to measuring female participation across the Australian science and innovation ecosystems include:

* small business owners by gender
* entrepreneurs (including start-up founders) by gender
* principal managers by gender
* women in vocational education and training (VET) and Higher Education-trained professions
* women in research, including research masters degrees, PhDs, post-docs, and ARC grants.

Data are also needed for other diversity groups to assist policy and program development around participation and inclusion in innovation. Diversity data will assist with evaluating the contribution diversity groups make to innovation development in the Australian economy more broadly, and if Australian government programs are genuinely equally accessible to all, or their design favours certain groups.

**Current state of play**

There are gaps in the collection of diversity data in businesses and management. The BCS Management Capability Module of 2015–16 was the first time the ABS asked about the gender of the principal manager of the business. However, this data set has not been collected again. Other than in this instance, ABS business surveys do not generally collect diversity information about the business owner.

There are gaps in innovation diversity data related to human resources dedicated to research, R&D and innovation. Many OECD countries report on the number of researchers in FTE terms (available in the MSTI database). This is a similar definition to that used by the ABS. The gender composition of the research workforce is reported in headcount terms. Australia does not produce equivalent data for the gender composition of the research workforce.

**Future outcomes sought**

Improved data and statistics in the area of human resource and business diversity are necessary for underpinning the development of new policies and programs, and for evaluating the effectiveness of those that currently exist.

The Review has not made specific recommendations on the additional diversity data to be collected but identifies this as an area for future research.

## Gaps where there are conceptual and measurement challenges

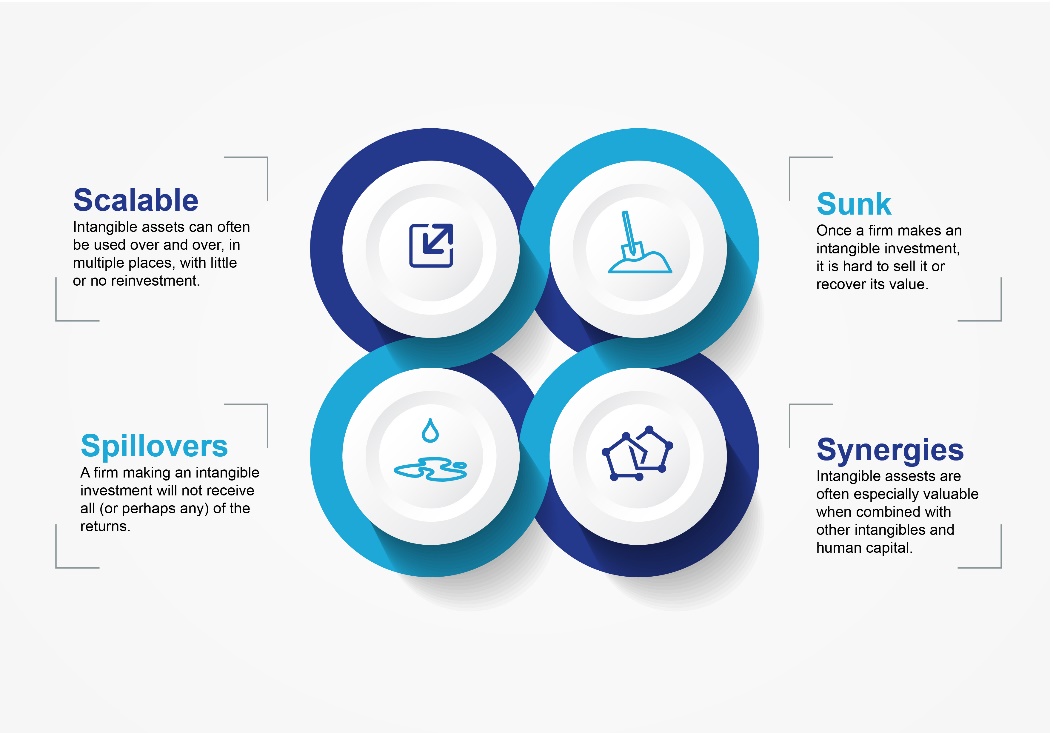
### Measures of intangible capital

**Why this is important**

The world has changed; the way we produce and consume has changed. The production of goods was relatively easy to observe and measure in the twentieth century. Assets such as buildings, machinery and computers were built, and this physical capital was combined with labour, raw materials and intermediate goods to produce output. Business investment in modern information technology tools is going beyond physical computer equipment into software and databases. Businesses are investing more in organisational capabilities, to develop their brand, implement business models and improve processes. They are relying less on physical material and more on intangible assets.

Intangible assets are those without a physical form, such as R&D, software, databases, artistic creations, designs, branding, and business processes. They are not new, but the increased scale of their use in production and their high level of international mobility are impacting developed economies worldwide. Intangibles are fast becoming the most important investment occurring.

The Review found that whilst not all intangible investment necessarily represents innovation, new ideas, new designs and new methods are increasing features of the innovation ecosystem, so intangibles are potentially a key source of underlying economic growth.

Figure 2.3: Properties of Intangible Assets – the four S’s

Source: S Westlake & B Mitra-Kahn, ‘Intangibles’, [Innovation Metrics Review Workshop Proceedings 13–14 March, 2019](https://www.industry.gov.au/sites/default/files/2019-05/innovation-metrics-review-workshop-proceedings.pdf), pp 25–27, adpapted from J Haskel & S Westlake 2018, Capitalism without capital: The rise of the intangible economy, Princeton University Press.

The properties of intangibles are fundamentally different from those of tangibles, so this change matters. Intangibles have four notable economic properties: they are more likely to be sunk (as they are seldom saleable separately from the business that owns them), based on synergies, scalable (non-rival), and often involve spillovers (where much of the benefits of an investment may accrue to others), as shown in Figure 2.3).

The Review’s Intangibles Expert Working Group noted that intangibles are also mobile and present difficulties to current tax authorities. The significant impact of intangibles is highlighted by Societas Privata Europaea (SPEs), a form of limited company that exist solely to hold IP on behalf of a parent company, changing residency for tax reporting purposes and leading to Ireland’s real GDP jumping by more than 25 percent in 2015.[[61]](#footnote-62) The impact of such mobility puts pressure on countries to lower corporate tax rates.

Understanding the impact of intangible investment may help explain some of the peculiar features of the modern economy, including rising inequality and slowing productivity.[[62]](#footnote-63) Work has been undertaken in an Australian context that provides evidence of the role that intangibles play in the economy. It shows that a broad range of business sector intangibles can significantly affect productivity and that there is a role for public support of research and innovation in the Australian economy.[[63]](#footnote-64)

The level of intangible investment varies internationally. Some developed economies, such as Sweden, the US, the UK and Finland, have already seen the share of intangible investment overtake that of tangible investment when academic estimates of non-National Account intangibles are taken into account.[[64]](#footnote-65) In other developed economies, including Australia, the relative share of intangibles is rising (see Figure 2.4) but has not yet overtaken tangibles.

Figure 2.4: The increasing investment in intangibles as captured by the System of National Accounts

| The figure is a stacked area graph that shows the level of investment (y-axis) in intangibles captured within Australia’s System of National Accounts over the years (x-axis) from January 1986 to January 2019. Research and development accounts for around half of the total for part of the period, but its relative contribution declines from January 2016 onwards, when research and development expenditure levels out and investment in computer software climbs sharply. |
| --- |

Source: Australian Bureau of Statistics 2019, [Australian National Accounts: National Income, Expenditure and Product](https://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/5206.0Main%20Features3Jun%202019?opendocument&tabname=Summary&prodno=5206.0&issue=Jun%202019&num=&view=), cat. no.. 5206.0.

Haskel and Westlake argue that government support is a key factor in the variation across countries. Where businesses are not able to appropriate the benefits of investment, they will tend to underinvest. Governments may choose to intervene by providing more public investment in intangibles, to encourage a total level of investment at, or closer to, the optimum for their economies. For example, government spending on R&D is an important determinant of private sector investment.[[65]](#footnote-66)

Intangible capital is harder to value, and much harder to borrow against, due to its sunk nature. Investment in intangible capital is generally longer term and higher risk than investment in tangible capital, and thus is more suited to equity than debt financing.[[66]](#footnote-67),[[67]](#footnote-68) Equity holders are generally long-term investors who are willing to take risks and require no collateral, while credit markets can limit loans when faced with strong asymmetric information between those inside and outside a business, due to adverse selection and moral hazard problems.[[68]](#footnote-69)

Knowledge spillovers and information asymmetry affecting financing choices are classic market failures associated with investment in intangible capital. They have implications for government innovation policy. Theory suggests: providing clear, stable IP rights; creating a favourable environment for infrastructure investment (including telecommunications and urban development) that encourages spillovers are worthwhile. Creating tax credits for equity financing, or alternatively taxing debt interest payments but lowering overall tax rates to compensate, deploying national funds in particular ecosystems, and implementing policies to tackle the economic impacts of increased investment in intangibles, such as the increase in inequality that may be created, would also need to be considered.[[69]](#footnote-70)

Evidence to evaluate the effectiveness of policies to address these market failures is slowly emerging. Bloom, Van Reenen and Williams (2019) outlined some of the main innovation policy levers and described the available evidence on their effectiveness. These included tax policies to favour R&D, government research grants, policies aimed at increasing the supply of human capital focused on innovation, IP policies and pro-competitive policies.[[70]](#footnote-71)

A number of countries are using some of these policy levers. For example, Singapore’s Productivity and Innovation Tax Credit provides tax deductions for: the acquisition and leasing of IT and automation equipment; the training of employees; the acquisition and licensing of IP rights; the registration of patents, trademarks, designs and plant varieties; R&D activities; and costs incurred to create new products or industrial designs where the activities are primarily undertaken in Singapore.[[71]](#footnote-72)

The Review’s sectoral case studies found clear evidence that some Australian businesses are not able to capture the full benefits of their investments in intangibles. Some of these businesses were attempting to solve upcoming industry-level problems through co-operative funding arrangements, which were creating intangibles designed to address these issues. The good created by these intangibles, while not public in nature, was the joint property of all those participating in the industry and expecting to continue to do so, rather than those specific businesses which invested in the intangibles. Those negotiating such arrangements noted that businesses tend to underinvest in this context. Others were attempting to solve the problems faced by their particular business, but were underinvesting because they were aware that they could lose their intangibles investment if their business failed, or if the ideas they generated were used by others. Small business owners were underinvesting in training because of concerns that employees could use their new abilities to demand higher salaries, either within or outside of the business that paid for the training, hence the value of the investment could be lost.

At present, policymakers do not have a solid evidence base to understand current trends in the growth of intangible capital in the Australian economy. Evidence is also important to evaluate whether the right policy levers are in place to foster the accumulation of intangibles, and thus encourage productivity growth.

**What information do policymakers need?**

Through the consultation process, the Review was able to determine that there is increasing demand from stakeholders for more comprehensive measurement of intangible investment. As the proportion of investment allocated to intangible – rather than tangible – capital rises, it becomes more important to measure intangible investment well.

More comprehensive measures would better equip policymakers to understand how and where intangibles are contributing to economic growth, by providing an evidence base to respond to changes and determine where policy intervention might be appropriate (e.g. through refinements to tax treatments, competition and other policies), to maximise potential growth and well-being in the modern Australian economy.

**Current state of play**

Conceptually, intangibles include a broad spectrum of assets. Work has been undertaken internationally to develop a framework for the measurement of intangible assets. Corrado and Haskel et al. (2012) categorise intangible assets under the following types.[[72]](#footnote-73)

* Computerised information
* Software
* Databases
* Innovative property
* Mineral exploration
* R&D
* Entertainment and artistic originals
* New product/systems in financial services
* Design and other new product/system
* Economic competencies
* Brand equity (e.g. advertising, market research)
* Business-specific resources (e.g. training, organisational structure).

Some of these are difficult to measure.

While all countries account for investment in tangible assets in their gross domestic product (GDP) statistics, no country currently includes a comprehensive estimate of business investment in intangible assets in their official accounts.[[73]](#footnote-74)

The current System of National Accounts (SNA) includes some intangible capital formation – R&D; mineral and petroleum exploration; entertainment, literary and artistic originals; computer software; and ICT investment. It excludes other types – design and other product development; training; market research and branding; business process re-engineering; the value of data collected and network formation. It does not capture the value of data created, just the cost of collecting or creating it.

All intangibles in scope of the SNA are currently measured in the Australian National Accounts. However, the data sources and underlying assumptions covering new investment data, price deflators and capital stock have not been reviewed for some time, and there would be merit in doing so.

Internationally, work is underway on attempting to identify and measure intangibles that sit outside of the current scope of the SNA. Statistics Canada and the UK Office for National Statistics, for example, are developing experimental estimates that cover a broader spectrum of intangibles.

At present, Australia is not measuring intangibles that are outside the current scope of the SNA.

The Intangibles Expert Working Group of the Review provided input to the components of innovation diagram shown below (see Figure 2.5).

Figure 2.5: Components of innovation that are measured in the System of National Accounts

| Figure 2.5 (page 51) is a stylised table that shows the components of innovation that are measured in the System of National Accounts. The table shows that Research and Development; Mineral (& petroleum) exploration; Entertainment, literary and artistic originals; Computer software, and ICT investment (equipment and telecommunication) are measured in the System of National Accounts. The table also shows that Design and other product development; Training; Market research and branding; Business process re-engineering; Value of data collected; and Network formation are not measured in the System of National Accounts. The table also contains an insert showing that Gross expenditure on R&D (GERD) is made up of Business expenditure on R&D (BERD), Government expenditure on R&D (GovERD), Higher education expenditure on R&D (HERD), and Private non-profit expenditure on R&D (PnPERD). The point of this is to show that Business expenditure on R&D (BERD) is only one component of Gross expenditure on R&D (GERD), and this in turn is only one of the components of innovation, despite the intense focus of the media on Business expenditure on R&D (BERD). There are more components of innovation not measured than those that are measured. |
| --- |

Experimental work is needed, building on that undertaken by national statistics offices internationally, to measure intangible capital more comprehensively.

The Review’s Intangibles Expert Working Group noted the difficulties associated with measuring intangibles:

‘…the lack of observable transactions, business accounting valuation rules, and other factors mean that NSOs may need to use second and third order approximations of market value, such as sums of costs, which are the observable amounts that are spent to create intangibles. Nonetheless, in using such approximations, it is important not to lose sight of the underlying principle of market value.’

It also offered the following advice.

‘…the ABS should trade-off errors of commission against errors of omission in trying to measure intangibles. Measuring intangibles is very hard, but only measuring what is easy to measure accurately is not particularly useful to policymakers. The ABS should aim for less accuracy and more utility’ in relation to the measurement of intangibles.[[74]](#footnote-75)

**Future outcomes sought**

1. Leverage the work currently being progressed internationally in the measurement of intangibles to develop experimental estimates of intangible capital for Australia outside of the SNA.
2. Review and update the data sources and assumptions underlying intangible capital measurement within the SNA.

| **RECOMMENDATION 2.7: INTRODUCE AND IMPROVE MEASURES OF INTANGIBLE CAPITAL** |
| --- |
| The ABS should develop experimental estimates of intangible capital items not covered within the System of National Accounts (SNA)  The ABS should review and update the data sources and assumptions underlying intangible capital measurement within the SNA. |

### Measuring the impact of digital activities in the economy

**Why this is important**

Rapid advancements in digital technologies in recent years have significantly transformed the ways in which households, business and governments interact with each other. Digital activities have grown rapidly and become an important contributor to economies around the world. As a result, the demand for data about the digital economy and its measurement is becoming increasingly important for governments, businesses, and academics.

Australian governments need information on where and how the Australian economy has been most impacted by digitalisation, to enable them to understand impacts, respond to changes and ensure the right policy levers are in place to maximise future economic growth.

**What information do policymakers need?**

Over recent years, there has been growing discussion internationally focused on developing a framework for measuring the digital economy, including exploration of a satellite account.

Stakeholders have indicated that development of an Australian digital satellite account would provide a basis for policymakers to respond to questions regarding digital activities in the economy and its impacts. However, it was established that policy needs could be partially met though development of measures of components that may contribute to a future digital satellite account. This is more achievable in the medium-term.

As a priority, policymakers are interested in understanding:

* the total value of e-commerce (digitally ordered goods and services) and its links with data flows, which relate to global supply chains
* the level of investment in digital technologies (such as cloud computing) occurring in the economy
* the total value of services provided by intermediary platforms as a separate proportion of the overall value of goods and services being provided by the producer
* the imputed value of free services (including data) that are not currently captured by the ABS within the SNA.

Measures in those areas would provide an evidence base to better equip policymakers to understand how and where digital activities are contributing to the economy and determine if and where policy intervention might be appropriate, to maximise potential growth and well-being in the digital era.

**Current state of play**

The digital economy poses significant measurement challenges for macroeconomic statistics. Many aspects of the Australian digital economy are captured in the National Accounts. However, this does not separately identify all digital activities, nor trace the estimated aggregate economic performance to its digital origins. It is recognised internationally that producing these data is challenging, due to definitional, classification and measurement issues:

* As highlighted by Ahmad and Ribarsky[[75]](#footnote-76) (OECD, 2018), the multi-dimensional nature of the digital economy creates difficulties in defining it. As a result, there is a lack of a commonly understood definition.
* The occupational and industrial classification systems in current use reflect a pre-digital world.
* There is currently no conceptual framework in place to identify and value digital activities occurring in the economy separately.

A considerable amount of research has been undertaken by international organisations, most notably by the OECD, to address these measurement challenges and develop appropriate measures.

For example, in March 2019, the OECD hosted a ‘[Going Digital Summit’](https://www.oecd.org/going-digital/summit/)[[76]](#footnote-77) which was the culmination of a two year project looking into policy development and measurement in the digital space. At the summit, the OECD released ‘[Measuring the Digital Transformation: A Roadmap for the Future](https://www.oecd.org/going-digital/measuring-the-digital-transformation-9789264311992-en.htm)’[[77]](#footnote-78)that identifies gaps in the current measurement framework, assesses progress made towards filling those gaps, and sets-out a forward-looking measurement roadmap.

A G20 summit held in Argentina in late 2018 produced a [toolkit for measuring the digital economy](http://www.oecd.org/g20/summits/buenos-aires/G20-Toolkit-for-measuring-digital-economy.pdf).[[78]](#footnote-79) The toolkit proposes potential measurement approaches which support policymaking and diagnose challenges and opportunities in relation to the digital economy. The toolkit is also intended to serve as a guide for countries wanting to align and adopt some standard measurement activities.

There has been significant discussion internationally on the development of a digital satellite account that delineates key digital actors and transactions within the National Accounts Framework.

The Australian Government has ongoing engagement with international organisations such as the OECD and the G20 through the ABS and the DIIS on the development of digital economy measures.

In 2018, the OECD released a proposed framework for Digital Supply-Use Tables to enable the creation of a digital satellite account that could provide a broadly holistic view of digital activities in the economy. At present, no NSO has adopted the framework, although a number of them are assessing it. The level of investment that would be required, and the suitability of the framework for adoption in the Australian context, is currently unknown.

The ABS has published [experimental estimates of digital activity in Australia](https://www.abs.gov.au/websitedbs/D3310114.nsf/home/ABS+Chief+Economist+-+Full+Paper+of+Measuring+Digital+Activities+in+the+Australian+Economy)[[79]](#footnote-80) based on methodology developed by the US Bureau of Economic Analysis (BEA).

There is an opportunity to leverage the work that has already been undertaken, however, further development of such methodologies will require additional investment.

**Future outcomes sought**

* Address information gaps related to digital activities occurring in the Australian economy
* Provide Australian governments with an evidence-base regarding the impacts of digitalisation of the economy
* Enable Australian governments to undertake and evaluate new policy related to digitalisation and encourage potential growth in the digital economy
* Develop measures that can contribute to a future digital satellite account
* Contribute to the international body of knowledge and influence the development of internationally comparable indicators related to measurement of the digital economy.

| **RECOMMENDATION 2.8: INTRODUCE AND IMPROVE MEASURES OF DIGITAL ACTIVITIES IN THE ECONOMY** |
| --- |
| The ABS should leverage work being undertaken internationally and assess how digital activity measures can be developed, prioritising the following information needs:   * The total value of e-commerce (digitally ordered goods and services) * The level of investment in digital technologies (such as cloud computing) occurring in the economy * The total value of services provided by intermediary platforms as a separate proportion of the overall value of goods and services being provided by the producer * The imputed value of free services (including data) that are not currently captured within the System of National Accounts.   In the longer term, these measures may contribute to a future digital satellite account. |

### Measuring government innovation procurement

**Why this is important**

Government procurement can act as a significant driver of innovation within Australian businesses. Increasing government procurement of innovative new products and services would be expected to have a positive effect on national innovation performance, however, improved data are necessary if such effects are to be measured and demonstrated.

Recommendation 15 of the ISA 2030 Plan is to:

‘Increase the use of innovative procurement strategies to improve outcomes and optimise government operations by establishing programs that promote, track and report on progress towards procurement practices that drive innovation (including identifying impediments raised by industry, and measuring participation of businesses by age and stage) across all levels of government’.[[80]](#footnote-81)

There is considerable work underway to develop challenge-based approaches in government procurement processes to identify and encourage innovation. For example, the Business Research and Innovation Initiative (BRII), administered by DIIS, provides small to medium-sized enterprises with competitive grant funding to develop innovative solutions for government policy and service delivery challenges. The awarding of contracts is important as contracts encourage business engagement with the public sector whereas grants encourage research.

**What information do policymakers need?**

Data that will enable evaluation of the impact of innovative procurement strategies now, and how and where to target investment to obtain best value for money.

A measurement approach that enables international comparison of performance.

**Current state of play**

There is a gap in measurement relating to Australian, state and territory government procurement (see Table 10 in Appendix E). At present, contracts and grants for new or significantly improved goods and services are not earmarked as different from those for goods and services that are already available within government procurement processes.

Internationally, there is work being undertaken by the European Commission to develop measures on government procurement for innovation.

**Future outcomes sought**

* Provide policymakers with data that will enable them to evaluate the impact of innovative procurement strategies now, and how and where to target investment to obtain best value for money
* Adopt a measurement approach that enables international comparison of performance.

| **RECOMMENDATION 2.9: MEASURE GOVERNMENT INNOVATION ACQUISITION** |
| --- |
| The Australian Government regularly enters into arrangements to acquire new or significantly improved products (goods and services) and processes. At present it does not distinguish arrangements for acquisition of those innovative products and processes from other products.  Investigation, organised by the responsible entity, is needed to determine how data on government acquisition of innovative products and processes could be collected, in order to measure their worth and effect on encouraging innovation. Ideally, an approach that enables international comparison of performance should be adopted. |

### Measures of entrepreneurship: start-ups and spin outs

**Why this is important**

New business formation has a key role in the generation of employment and the diffusion of knowledge. Innovation-based and growth-oriented start-ups are a form of business experiment that can discover new opportunities for value creation. Such businesses can have major impacts on innovation, employment, industry development and structural change, and have a vitally important role in times of rapid change, when they are key sources of learning and dynamism. It is important to be able to distinguish between innovative and replicative start-ups (see Appendix E).

It is recognised that entrepreneurship, in particular, is a key economic driver and has strong linkages with innovation. Entrepreneurship is seen as the critical link between new knowledge and economic growth, as it facilitates the transfer of knowledge.[[81]](#footnote-82)

Australian governments invest significant resources into programs designed to support entrepreneurship activity. There is increasing demand for measures that support both domestic analysis of policy and program effectiveness (including comparisons between Australian jurisdictions) and international comparison.

**What information do policymakers need?**

Internationally comparable indicators that enable conclusions to be drawn about the level of entrepreneurial activity in Australia and other countries.

Indicators that provide meaningful measures of:

* entrepreneurial activities
* enablers and drivers of entrepreneurship (e.g. access to finance, capabilities)
* the impact of entrepreneurship on economic performance
* the dynamic nature of entrepreneurship and the resulting business dynamics.

Indicators should specifically capture the innovative nature of entrepreneurship.

**Current state of play**

The Review recognises entrepreneurship is an area of innovation activity where current measures are limited. Current international rankings do not provide meaningful measures that can guide policy-making.

There are a number of challenges when it comes to measurement of entrepreneurship:

* Entrepreneurship is a dynamic and complex activity that is difficult to measure.
* Entrepreneurship is a concept that encompasses a number of different activities of which there are no clear definitions.
* Separating entrepreneurial activities from other business activities is often difficult.

The Global Entrepreneurship Monitor (GEM) is currently the primary source of entrepreneurship data and is collected through two streams: the Adult Population Survey (APS) and the National Expert Survey (NES). The OECD publication, *Entrepreneurship at a Glance,* cites GEM as being a key data source for metrics in entrepreneurial capabilities and entrepreneurship culture.

GEM has been funded by DIIS in the past and is generally used because there is no alternative that provides a similar level of coverage and claimed comparability. However, the Review notes the limitations of GEM data, due to its small sample size and limited coverage.

There is currently work being undertaken internationally on developing methods to aid measurement. For example, the OECD has launched two projects, MultiProd and DynEmp, which rely on cutting-edge techniques and business-level data to better understand the relationship between policy and productivity, and the role that start-ups have in boosting productivity, creating jobs and raising innovation in the economy.[[82]](#footnote-83)

In Australia, the ISA is funding consultation work with key stakeholders to build on the information about user needs for data in this area that was reported to the Review, and enable specification of the data that should be collected in future.

In Australia, there is no national consensus on the most appropriate definitions to use to collect data and produce metrics to measure the success of government policies and programs targeting start-ups. At present, each Australian government department is trying to make sense of disparate sets of data generated by its own programs and by private data providers in isolation.

Once Australian, state and territory governments and ecosystem leaders have agreed on the data needs they have in common with regard to entrepreneurship, start-ups and spin-outs, this data should be captured and reported upon.

**Future outcomes sought**

* Provide policymakers with measures that facilitate meaningful analysis of entrepreneurship activity
* Provide internationally comparable indicators that enable conclusions to be drawn about the level of entrepreneurial activity in Australia and other countries.
* Enable evaluation of the effectiveness and impacts of policy and programs designed to promote entrepreneurship activity.

| **RECOMMENDATION 2.10: INTRODUCE AND IMPROVE MEASURES OF ENTREPRENEURSHIP; START-UPS AND SPIN OUTS** |
| --- |
| Work is needed to define the conceptual basis for measurement and development measurement systems that enable conclusions to be drawn about the level, performance and drivers of entrepreneurial activity in Australia and other countries  The responsible entity should coordinate this work drawing on expertise from the international and domestic research community, relevant policy areas, and other stakeholders. |

### Business access to finance for start-ups

**Why this is important**

New business formation is vitally important to realise new opportunities for value creation. As noted in the DIIS’s 2017 AISR, a lack of funds for the higher risk early stages of innovation may impose significant limitations on the growth potential of innovative and disruptive businesses in Australia.

**What information do policymakers need?**

Policymakers are interested in understanding business access to finance and other forms of investment (VC, angel investors, crowd sourced equity funding, grants, accelerators, venture debts) for start-ups.

There is a strong preference for internationally comparable data.

**Current state of play**

In Australia, a primary source of data on access to finance for innovative start-ups businesses is the VC&LSPE, collected by the ABS. This survey is funded by the DIIS. The survey of VC&LSPE does not cover all forms of company investment (it excludes angel-investment, crowd-sourcing, and accelerators) because there is currently no way to identify and create a survey frame to include them.

There is currently no internationally agreed upon definitions of VC, which precludes meaningful international comparison of data. Many NSOs don’t collect venture capital information.

**Future outcomes sought**

* Provide policymakers with data that will enable them to evaluate business access to finance and other forms of investment (VC, angel investment, crowd sourced equity funding, grants, accelerators, venture debts) for start-ups
* Enable international comparison of Australian data on access to finance by start-ups.

| **RECOMMENDATION 2.11: IMPROVE MEASURES OF ACCESS TO FINANCE FOR START-UPS** |
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| The responsible entity should investigate the compilation and connection of alternative public and private data sources for the measurement of access to finance; including use of angel investment, crowd-sourcing and accelerators. The investigation should assess whether there is an alternative to the VC&LSPE Survey to meet the need for data on access to finance over the longer term  In the interim, the ABS should continue to undertake the VC&LSPE Survey. |

### Measures of labour force skills, rather than qualifications

**Why this is important**

Employers have long used qualifications and experience as a proxy for skills. As tasks within jobs change, employers are increasingly seeking employees who have qualified more recently (e.g. those with only three to five years of experience since obtaining a tertiary qualification). Employers are also demanding employees with digital skills to work with the latest technology. Those skills are not taught as part of formal qualifications.

Ongoing investment in developing workforce capability can generate significant dividends for sponsoring businesses in the long run, including improved productivity, the delivery of better quality products and services, and enhancement of business growth prospects.

Manager and director skills are also contributors to business profitability and growth.[[83]](#footnote-84),[[84]](#footnote-85)

**What information do policymakers need?**

Policymakers need to know what skills the Australian workforce has, and what skills Australian employers are seeking, to address the gap through training or net immigration.

Policymakers need improved accuracy and granularity of the data it collects on business workforce training. Measures that link investment in skills with the subsequent performance of the business will also enable an assessment of whether skills needs are being met (see Table 10 in Appendix E).

**Current state of play**

The ABS collects data on qualifications and occupations but there is currently no way of linking demand and supply data.

The Department of Employment, Skills, Small and Family Business (DESSFB) is working on developing a new skills-based approach to labour market analysis to explore the relationship between jobs, skills and education. The work is intended to support individuals, employers and education providers to make more informed decisions and improve the policy responses of Government by enabling occupation and qualification data to be linked.

The Jobs and Education (JEDI) project integrates disparate and isolated labour market and education data to produce meaningful and accessible information, features and insights and tools.

DESSFB is mapping jobs to qualifications based on skills, understanding skills transferability, upskilling and identifying skills supply and demand mismatches in the economy which would lead to the identification of skills emerging in the labour market.

The OECD’s PIAAC survey measures adults’ proficiency in key information-processing skills and gathers information and data on how adults use their skills at home, at work and in the wider community. PIAAC was conducted by the ABS in Australia in 2011–2, and a second cycle is in planning and development, to be conducted in 2021–2.[[85]](#footnote-86)

**Future outcomes sought**

* When DESSFB has completed its skills classification work, an indicator based on skills should be investigated for addition to the innovation Scorecard
* An understanding of the broader coverage of skills proficiency in the working age population.

**Options to be considered**

* Work with DESSFB to ensure the latter’s work also meets the innovation ecosystem’s need for skills data
* Recommendation 15 of the Senate Inquiry for the Australian Government to work with the ABS and the National Centre for Vocational Education and Research to investigate and establish a research instrument to enable analysis of employer investment in the development and training of their workforces[[86]](#footnote-87)
* When available, investigate the substitution of the education output measurement from PISA to PIAAC.

### Location-based innovative activities (e.g. state and territory-level innovation indicators, innovation clustering)

**Why this is important**

There is increasing demand from state and territory governments for indicators that allow policymakers to evaluate innovation policies and programs implemented at jurisdictional and lower levels. Capturing information from businesses on the location of innovative activities would improve understanding on the relationship and impact of specific innovation initiatives.

**What information do policymakers need?**

Innovation measures that provide an understanding of the relationship between location and a range of innovation activities. For example, state and   
territory-level innovation indicators or indicators of innovation clustering.

**Current state of play**

There is currently no source that allows evaluation of innovation activities within, or across, jurisdictions, let alone at lower levels. There is interest in regional analysis and in assessing the impact of innovation precincts..

There has been increasing demand for business innovation indicators to be provided at a state or territory level. However, there are challenges for collecting this information from businesses, particularly for businesses operating in multiple locations and in multiple jurisdictions.

Given this, it is important that government administrative and transactional data collections include location information wherever possible. This may enable some answers to be found by data integration through BLADE.

**Future outcomes sought**

* Provide jurisdictions with an improved understanding of the relationship between location and a range of innovation activities.
* Enable policymakers to evaluate innovation policies and programs implemented at the state and territory level.

| **RECOMMENDATION 2.12: MEASURE LOCATION-BASED INNOVATION** |
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| The responsible entity to investigate solutions, by working with the ABS and other relevant parties, to build location-based capability into Australian innovation data. Data custodians should be encouraged to collect location data that supports analysis of location-based innovative activity. |

### Measuring business capability to implement innovation

**Why this is important**

There is growing evidence that links business management capabilities to innovation performance and productivity outcomes. This is noteworthy, considering a recent Australian Institute of Company Directors innovation report indicated that innovation is often missing from boardroom agendas.[[87]](#footnote-88) Business management capabilities can influence a business’s ability to undertake innovation activities, introduce innovations, and generate innovation outcomes.

The relationship to innovation is indirect and relates to business’ ability to identify and transform new knowledge (i.e. absorptive capacity), effectiveness of resource use (most notably human resources), and the value of assets.

Capturing information on management capabilities in Australian businesses, particularly with respect to absorptive capacity, would assist the development of policies and programs targeted at improving management capability.

**What information do policymakers need?**

Internationally comparable data that measures the management and organisational capabilities in Australian businesses, including relationship capital and overall absorptive capacity (see Table 10 in Appendix E).

**Current state of play**

The ABS was funded by DIIS to conduct a Management Capabilities Module (MCM) of the Business Characteristics Survey (BCS) in 2015–6. This survey module was designed to support international comparisons of management practices and the analysis of the impact of different levels of management sophistication on business productivity and performance.

Currently, the international comparability of this data is limited. A similar survey was run in the United States (US) in the manufacturing sector (2011 and 2016), but the MCM was the first national survey to collect this type of information across a whole economy. The Review understands that the UK, Canada and Germany intend to (or have already) developed survey content relating to management and organisational capabilities. It is not currently known how their measures will align with those produced for Australia.

Users have indicated that minor changes could be made to the survey content of the MCM. The MCM provides meaningful measures that would support policy development in this space. They have also indicated that some questions are much more valuable than others in generating policy-relevant information.

Alternative options to measure business capabilities to innovate (outside of surveys) have not been identified and would require further investigation.

It may be advisable to wait until more is known about the approaches currently being progressed internationally and their relative effectiveness before proceeding further in this space. In the meantime, very high value questions could be considered in the context of the standalone innovation survey and business use of digital technologies survey.

**Future outcomes sought**

* Provide policymakers with measures that facilitate meaningful analysis of the management and organisational capabilities of Australian businesses
* Assist with evaluation of policies and programs targeted toward improving management and organisational capabilities of Australian businesses and understanding of the impact of different levels of management sophistication on business productivity and performance
* Provide the international community with an evidence base for the effective measurement of management and organisational capabilities, enabling greater international comparability of data going forward
* Data with a balance of short-term and long-term performance objectives in corporate governance (see Table 10 in Appendix E of the literature Review)
* Develop approaches to identify the significance of high performance in multiple capabilities simultaneously (i.e. cumulative capability).

**Options to be considered**

* Develop statistical solutions that will facilitate meaningful analysis of the management and organisational capabilities of Australian businesses; including absorptive capacity.[[88]](#footnote-89)

### Research commercialisation activities

**Why this is important**

The commercialisation of research is the generation of a commercial benefit from research to contribute to Australia’s economic, social and environmental well-being.

An effective and timely diffusion process is necessary for the knowledge created by research institutions to find its way into market applications. There is an increasing government focus and investment on knowledge transfer and collaboration through government policies that have an increasing focus on tracking performance and return on investment.

**What information do policymakers need?**

To be able to monitor the performance of research institution commercialisation partnerships to track the success of publicly funded research organisations (PFRO) in terms of research translation and commercialisation.

**Current state of play**

There is currently no international conceptual framework for the measurement of research commercialisation activities. Internationally, surveys are run by AUTM. AUTM is an association of technology transfer professionals, formerly known as the Association of University Technology Managers, until its scope increased to include research centres, hospitals, businesses and government organisations, as well as universities in the US and Canada. AUTM measures trends and shares research commercialisation insights about the technology transfer industry and those who work within it.[[89]](#footnote-90) In addition, current measures focus on start-ups, spinouts and licensing agreements. However, there is an increasing body of evidence that suggests academic engagement and impact can be measured through contract research and consultancies.[[90]](#footnote-91)

User consultation has determined that the National Survey of Research Commercialisation (NSRC) collects some innovation data, modelled on internationally comparable data, deemed important by stakeholders and not available through other channels. It collects data that enables some system-level performance monitoring of PFRO. These data are used in prominent innovation collections, as well as internal benchmarking by – and external promotion of – PFRO.

Most research organisations now have a strong focus on knowledge transfer and collaboration activities, due to government policy. They need to monitor the performance of research institution commercialisation partnerships to track the success of PFRO in terms of translation and commercialisation.

The NSRC only partially meets this need.

**Comments**

* High quality data are necessary to deliver a worthwhile evidence base for decision-making to support research commercialisation
* There are significant data quality issues impacting on the utility of those aspects of the current survey used for public good purposes (and the Australian Government should not be funding aspects used for private purposes, or to generate public good data that can be readily obtained in another way).

**Future outcomes sought**

* Before undertaking any further work, a commitment should be obtained from the subset of PFRO whose systems do not collect high quality data to improve that data (for example, by developing the ability to identify when multiple collaboration projects occur with the same business)
* If such a commitment is given, then further work should be undertaken, given the increasing government focus on – and investment in – knowledge transfer and collaboration through government policies that require tracking performance and returns on investment
* Over the longer term, it would be desirable to have internationally comparable indicators that enable conclusions to be drawn about research commercialisation activities in Australia and other countries
* There is currently no international conceptual framework for the measurement of research commercialisation activities, and there are a number of challenges related to its measurement
* A conceptual framework should be developed, preferably in conjunction with international counterparts, or at least shared with them upon completion
* This framework should focus on the success of PFRO in terms of translation and commercialisation of ideas in conjunction with the business community and draw on existing concepts where possible
* A revised survey could be implemented, either by a private sector or government entity with the appropriate expertise. This should leverage existing administrative data collected through the Watt Review’s recommendations and sources such as joint grant, tax relief and IP applications.[[91]](#footnote-92) The main benefit of such a survey comes from sharing unit level information. While the ABS can release the unit level data of entities with their written permission, it is not well set up to do so on a large scale. There are other entities, such as LH Martin, KCA and the Australian Institute of Health and Welfare, which may be better situated for this work. Tenders could be sought once the aims of the new survey had been fully determined, following completion of the conceptual work
* The objective of the revised survey would be to enable users to evaluate the effectiveness and impacts of policies and programs designed to promote research commercialisation.

| **RECOMMENDATION 2.13: IMPROVE MEASURES OF RESEARCH COMMERCIALISATION** |
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| The collection of data through the National Survey of Research Commercialisation by the Department of Industry, Innovation and Science should be discontinued  The responsible entity should coordinate the development of a conceptual framework for the measurement of research commercialisation activities. This should focus on measuring the success of publicly funded research organisations, in commercialising their ideas in conjunction with the business community  The responsible entity should commence the collection of hitherto unavailable research commercialisation data. The entity will ensure this data can be properly measured and is important to stakeholders. |

### There are gaps in the understanding of networks

**Why this is important**

The increasing role of external interactions in innovation means that businesses are now embedded in ‘innovation networks’ (see page 24 in Appendix E). The extent and quality of innovation networks is an external resource of significance for business-level innovation capacity. Inter-organisational relations in innovation networks include market and non-market interactions for which trust and social capital are important foundations. Such networks are increasingly international, due to the globalisation of value chains, the rise in international investment, and the wider dispersion of research and innovation capacity.[[92]](#footnote-93)

Networks are also present between public and private institutions.

Innovation does not take place in isolation. Maintaining the correct balance of these networks allows innovation actors to thrive. Too tight and actors become blind to opportunities; too weak and there are insufficient capabilities to act upon these opportunities.[[93]](#footnote-94)

**What information do policymakers need?**

Policymakers need to be able to understand the knowledge and supply linkages in the economy better to be able to reveal the full impacts of innovation. They need to understand how networks fail and thrive to determine when inputs are necessary to support innovation-linked productivity improvements.

**Current state of play**

There are significant gaps in innovation measurement related to flows, networks and clustering of human resources within Australia’s innovation ecosystem (see Table 10 in Appendix E).

LinkedIn and other private sector data sources have investigated the identification of flows of skills, relationships between organisations and sectors, the innovation capabilities of businesses, and the existence of clusters. Such data could also enable an increased ability to measure changes in demands for various types of skills over time, and within various geographical locations.

**Future outcomes sought**

* Improve the ability to undertake and evaluate new policy development related to networks and clusters of innovation by improving the evidence base
* Improve indicators to enable a closer understanding of research-industry links
* Identify the role of supply chains and clusters in innovation knowledge flows and inducement.

**Options to be considered**

* The Australian Government should work with LinkedIn and other data providers to develop new metrics related to human resources, networks and knowledge flows.

### There are gaps in the measurement of public sector innovation

**Why this is important**

Governments exist in an environment of fiscal restraint and are constantly searching for ways to deliver more, better or cheaper services to the public. In Australia, the public sector contributes to over 20 percent of GDP (see page 27 of Appendix E). The key difference between a government unit and a public corporation is that the former do not charge economically significant prices for their goods or services.

Governments set the underlying environment that allows private sector innovation to drive the economy.

**What information do policymakers need?**

While it is relatively simple to measure inputs, it is far more difficult to measure outputs and outcomes.[[94]](#footnote-95) For example, from a human capital perspective, it is not enough to know if participants were satisfied with a training course. The need is to understand how individual performance or business outcomes improved as a result of the training course. Measures of innovation in the broader workplace can be similarly flawed if they focus on the number of new ideas generated, rather than the number that were developed and implemented to deliver benefits.

The Australian Public Service has many useful input measures for understanding the workforce, but few output measures to allow it to determine the impact of its investment in workforce capability. This does not involve merely picking up the measures used by the business community or other sectors and applying them to the public sector. Whilst much can be learned from other sectors, there is also much that is distinctive about the public sector, including innovation in the public sector. Consequently, there is a need to build an evidence-based understanding of public sector innovation from the data that is available to government entities.

**Current state of play**

There is currently no internationally comparable collection of public sector innovation data. Arundel *et al.* recently reported that ‘The fourth edition of the Oslo Manual provides a universal definition of innovation that is applicable to all sectors covered by the SNA, and includes a brief discussion of the value of collecting data on public sector innovation.’[[95]](#footnote-96) The authors proposed a framework for the measurement of public sector innovation that goes beyond – but is broadly compatible with – the Oslo Manual, and would permit benchmarking innovation activities between the public and business sectors.

A key difference is the Oslo Manual does not require a change to be normatively better than existing products or processes for it to be considered an innovation, whereas the work of Arundel et al. does.[[96]](#footnote-97) Restructuring in the public sector is relatively common and is not considered as an innovation unless there is an improved outcome or benefit.[[97]](#footnote-98)

**Future outcomes sought**

* Provide policymakers with data that will enable them to evaluate the impact of public sector innovation in the economy
* Adopt a measurement approach that enables international comparison of performance.

**Options to be considered**

* Further investigation is needed to determine how data on government innovation impacts and outputs could be collected. Ideally, an approach that enables international comparison of performance should be adopted.

### There are gaps in the understanding of the impacts of innovation

**Why this is important**

“Innovation helps businesses improve the way they work, solve everyday problems and drive long-term job creation. It is also a key driver of productivity growth and economic renewal.”[[98]](#footnote-99) Innovation within the business, research organisation or government has spillover impacts on industries, regions, and across the entire economy.

While the Review has limited its attention to the economic benefits arising from innovation, a much broader range of impacts are taking place and are capable of being examined and evaluated. These include social, environmental, cultural and other impacts, both positive and negative.

Different approaches to innovation measurement could be used to offer an improved understanding of the impacts of innovation that occurs in Australian businesses (including the cost savings, economic benefits and productivity improvements resulting from innovation).

**What information do policymakers need?**

A need exists to examine the social, health, environmental and other public spillover benefits arising from innovation. A number of overseas bodies are considering these broader impacts as part of their innovation policy, and the Australian Government should do so as well.

Determination of the flows of particular innovations throughout the sector to investigate their impacts.

**Current state of play**

The current ‘subject-based’ approach to capturing data within the BCS (which focuses on the business and collects data on all of its innovation activities) is likely to be blind to a number of important aspects of the innovation activities of businesses.

For the first time, the fourth edition of the Oslo Manual (2018) includes a chapter on the object-based approach to measurement of innovation. The chapter outlines how the current approach can be complemented with additional information by collecting data on a single “focal” innovation.

**Future outcomes sought**

* Understanding the impacts of innovation that go beyond those that are economic-based
* Quantify the extent to which spillover benefits occur within the economy.

**Options to be considered**

* Expanding the scope of ongoing innovation measurement Reviews to consider the impacts of innovation that go beyond economic impacts
* A research project on the ‘object-based’ approach to innovation should be conducted on behalf of the body responsible for ongoing measurement of innovation. This piece of work should form part of any roadmap for future measurement of innovation.

### There are gaps in the understanding of sources of innovation (including capability)

**Why this is important**

Innovation is increasingly interactive and distributed across organisations, fields of knowledge, and regions, in a complex division of innovative labour. Hence, a focus on innovation at the business level is not adequate. Businesses’ capabilities for innovation are also developed outside the context of specific innovation projects through flows of knowledge through personnel and other mechanisms. Studies also show that the majority of the knowledge flows from external sources are informal, through non‐market mechanisms, and hence are not priced (see page 28 in Appendix E).

**What information do policymakers need?**

Up to date innovation measures that provide an understanding of the relationship between the sources of innovation location and a range of innovation activities. Further knowledge is also required on the type of innovation being brought into Australia by multinational corporations.

**Current state of play**

There is a gap in information available about R&D funded by overseas sources. Until 2008–09, GERD was estimated every second year. Following ABS work program changes, from 2010–11, it was no longer possible to derive a comparable estimate of GERD in the same manner. The current predictive model used to estimate GERD at the total expenditure level prevents the source of funds to be derived.

The Review’s case study determined that there are various sources for innovation. While these activities are qualitatively determined through surveys, such as the BCS, businesses could not quantify the scale of this activity, as there are no measures in place at the business level.

As described above, the DESSFB is mapping jobs to qualifications based on skills, understanding skills transferability, upskilling and identifying skills supply and demand mismatches in the economy, which would lead to the identification of skills emerging in the labour market.

**Future outcomes sought**

* Provide stakeholders with an improved understanding of the relationship between the sources of innovation and a range of innovation activities.

**Options to be considered**

* Annual indicators of total expenditure on R&D across all sectors (GERD) and businesses (BERD) to allow the determination of R&D financed abroad
* Conduct sectoral analyses to gain a better understanding of innovation in that sector and how that innovation is sourced
* Work with the DESSFB to ensure the work also meets the innovation ecosystem’s need for capability sources data.

### There are gaps in understanding of the inputs into the innovation systems operating environment

**Why this is important**

The innovation system has many diverse actors who interact to produce and spread innovations that have economic, social and environmental value. The composition of the innovation system changes, as actors join and leave, and the intensity of activity also changes as investments and risk appetites rise and fall.

However, understanding the inputs into the innovation system’s operating environment is difficult. There are many diverse areas that enable innovation activities to occur and have impact, such as entrepreneurship, digital technologies and digital infrastructure, research infrastructure, measures of skills, business capabilities, and business’ access to finance, networks and educational structure. For example, there is a need to have a better understanding of the professional and educational characteristics of teachers, as they are a key determinant of student outcomes. Teachers teaching in-field (those who teach subjects and year levels for which they are qualified) are understood to produce higher quality teaching compared to teachers who teach outside of their field, leading to superior educational outcomes.

**What information do policymakers need?**

As the Australian economy continues to change and develop, inputs into the innovation system continue to evolve. There is a need for ongoing Review of the inputs into the innovation system to enable the most relevant measurement of the innovation system to be undertaken.

**Current state of play**

Responsibility for Australia’s innovation ecosystem, and for measuring its progress, is currently split across Australian, state and territory agencies. This makes the development of a national strategic approach for measuring innovation more difficult and time consuming.

In 2016, ISA was tasked with a performance Review of the Australian innovation system. This Review formed the basis of ISA’s innovation, science and research strategic plan for Australia – the 2030 Strategic Plan. ISA will review the performance of the innovation system every five years.

**Future outcomes sought**

* Ensure that current and new aspects of the innovation system are identified and addressed as the economy continues to evolve
* Enable Government to develop a more efficient, strategic national approach to innovation measurement
* Enable the tracking and reporting of the internationally comparable performance of the Australian innovation system.

**Options to be considered**

A responsible entity should undertake a Review of the operating environment for innovation, to be updated every three years starting in the second half of 2022. This Review timeframe is shorter than the current Innovation Science Australia directive for performance Reviews every five years. This is because the Review is expecting the underlying data used to assess the operating environment to improve more frequently as recommendations are implemented.

# Analysis

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| KEY POINTS   * Analysis of data is important to identify linkages across, within and between various innovation activities. Data and metrics alone are not enough to provide a complete evidence base of the innovation ecosystem and its performance * Analysis can also provide valuable insights on innovation and its links to outcomes, such as jobs, productivity growth, and social and environmental impacts * A significant amount of innovation-related research and analysis is being undertaken by government, academia, the private sector and international organisations * The Business Longitudinal Analysis Data Environment (BLADE) is being used to provide valuable insights that are used to inform policy decisions. The Longitudinal Linked Employer-Employee Database (LLEED) has the potential for broader use, including to provide answers to location-based policy questions * There is a groundswell of emerging opportunities to link existing datasets and utilise big data analytics to provide new insights to understand the Australian innovation landscape and innovation performance better * Barriers that prevent or limit research and analysis from being undertaken include visibility and accessibility of innovation-related data sources, analytical capability and capacity * Progressing innovation-related research and analysis requires a whole-of-government approach to develop solutions that can address such barriers * A coordinated approach to innovation-related research and analysis would enable the Australian Government to: * **identify whole-of-government requirements and priorities** * **draw on capabilities across Australian, state and territory government agencies, academia and the private sector to create a critical mass of resources and analytical capability.** |

## Analysis of innovation-related data is important

The Australian innovation ecosystem is complex and dynamic, with many components and diverse actors who interact to produce and spread innovations that benefit Australia. This complexity is illustrated by the Framework discussed in the Review Process and Methodology (see Figure i.4 and Table i.1).

The Review has identified gaps in the information that is required to support analysis and improve understanding of the innovation system to inform policy decisions. These findings, and potential solutions for improving the data that underpins innovation measurement, were discussed in Chapter 2. However, improving the data alone is not enough to provide a complete evidence base for the innovation ecosystem and its performance.

Analysis of data is important for several reasons:

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| **To provide deeper insights on innovation system performance and impacts**  Data and metrics alone are not enough to assess the performance and impact of innovation with sufficient clarity.  There is a need to identify linkages across, within and between various components of the innovation ecosystem.  Likewise, there is a need to understand enablers of innovation activities that are of critical importance to outcomes such as jobs, productivity growth, and social and environmental impacts. |

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| **To assess existing innovation measures and identify new and emerging needs and information gaps**  Data analysis and policy has a reflexive relationship – understanding which data are of policy relevance is aided by the analysis of data.  The analysis of existing data can help to identify those datasets that are fit for purpose and the data that are most useful to inform policy-making.  Analysis of data is important to indicate emerging needs and information gaps within existing datasets.  Changes in the Australian economy and emerging global trends, raises new measurement issues, research questions, and information requirements to inform policy development. |
| **To maximise the value of the large amounts of data being generated**  Vast amounts of data are being generated with increased digitalisation of the economy including in key areas of science, technology and innovation.  Research and analysis of data enhances the value of this data, and is useful to inform policy.  Opportunities exist to enhance the value of existing and new data sources through linkage of datasets. |

## A significant amount of research and analysis is currently being undertaken

A significant amount of innovation-related research and analysis is being undertaken by Government, academia and the private sector to inform policy. The following section provides an overview of the activities being undertaken.

### Analysis undertaken by the Australian Government

The Australian Government is a major source of innovation-related research and analysis. Australian Government departments and agencies are engaged in a range of research and analysis, from regular innovation system reporting, such as the DIIS’s [*AIS*](https://publications.industry.gov.au/publications/australianinnovationsystemmonitor/index.html) *Monitor*, IP Australia’s [*Australian IP Report*](https://www.ipaustralia.gov.au/about-us/data-and-research/australian-ip-report), the Australian Research Council’s [*Engagement and Impact Assessment*](https://www.arc.gov.au/engagement-and-impact-assessment), and the Australian Small Business and Family Enterprise Ombudsman’s [*Small Business Counts*](https://www.asbfeo.gov.au/sites/default/files/documents/ASBFEO-small-business-counts2019.pdf) report, through to specialised   
agency-relevant analytical projects and research.

Recent investments in BLADE (Box 3.1) and LLEED (Box 3.2) have enabled the Australian Government to deliver valuable insights on the economy. BLADE (Box 3.1) enables the correlation of factors associated with changes in performance, innovation, job creation, competitiveness and productivity to be assessed. LLEED (Box 3.2) has the potential to be used to answer a wide range of policy questions, notably those relating to locational questions.

Box 3.1: The Business Longitudinal Analysis Data Environment (BLADE)

| **What is BLADE?**  BLADE is an important statistical asset that has received significant investment and is used heavily across government to provide information on a range of economic research questions.  BLADE enables business datasets to be linked, using the Australian Business Number (ABN) as the identifier. It combines business tax data and information from ABS surveys over time to provide a better understanding of Australian businesses and the economy.  The current BLADE asset contains data on all active businesses from  2001–02 to 2016–17, sourced from:   * the Australian Taxation Office (ATO): Business Activity Statements (BAS), Business Income Tax (BIT) filings and Pay as You Go (PAYG) summaries * ABS surveys: BCS and MCM, Economic Activity Survey (EAS), Business Expenditure on Research and Development (BERD), Private Non-Profit Expenditure on Research and Development (PNPERD), Survey of Research and Experimental Development, Government (GOVERD) * IP Australia: Intellectual Property Longitudinal Research Data (IPLORD).   **How is BLADE currently being used?**  Authorised researchers working on approved projects can use BLADE data to study how businesses fare over time and the factors that drive performance, innovation, job creation, competitiveness, and productivity. BLADE demonstrates how combining existing public data can help to deliver evidence based policy making.  BLADE has been used by a number of agencies for research and program impact analysis. It is useful for analysing business performance and dynamics, business demography and characteristics.  The Department uses BLADE to:   * track the performance of actively trading businesses and trends in entries and exits over time * provide insights into the size and industry distribution of government program participants, and the impact these programs have * explore business characteristics, such as export status, foreign ownership status or innovation status. |
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| A list of approved research projects that use BLADE data can be found on the ABS website.[[99]](#footnote-100) |

Box 3.2: The Longitudinal Linked Employer-Employee Database (LLEED)

| **What is LLEED?**  LLEED is an important tool that is being developed by Treasury and the Department of Education.  LLEED includes personal and employer-level information provided to the ABS by the ATO and the Registrar of the Australian Business Register (ABR). It is a cross-sectional database comprised of a person file, a job file, and an employer file. Currently, it can be used to analyse more than 100 million tax records between 2011–12 and 2016–17.  LLEED also enables analysis of business and employment dynamics. Changes at the business-level that can be identified include: business entry and exit; growth and decline; mergers and acquisitions; and changes in workplace practices. Employment dynamics include: transitions between jobs; wage changes; geographical mobility; and movement in and out of the labour force.[[100]](#footnote-101)  This may enable the identification of some of the effects of innovation in small areas, which is not presently possible through other means. For example, productivity – of which innovation is reported as being the only way for the most developed countries to secure sustainable long run productivity growth – is affected by the characteristics of employees and employers at the business, industry and economy-wide level. LLEED could be used unpack the characteristics of leading businesses that lead to high rates of productivity growth, relative to the overall average performance of lagging businesses.[[101]](#footnote-102) It could also test the effects of human resource management practices on business and workplace-level productivity and performance.[[102]](#footnote-103) As it contains information about employee location, it has the potential to be used to answer questions about the spatial impact of innovation.  Under the legislation in place at the time of publication, this data can only be analysed by Australian Government analysts employed by the ATO. |
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Through the Data Integration Partnership for Australia (DIPA) (Box 3.3), Australian Government agencies are able to integrate program and transactional data into BLADE, providing them with a powerful tool to evaluate the effectiveness of existing policies as well as provide an evidence base for development of new policies and programs. Linking additional datasets would enhance analytical capabilities further. However, there are currently long lead times, due to the complexity of integrating new data sources, and the limited resources available to do so.

Box 3.3: The Data Integration Partnership for Australia (DIPA)

| **What is DIPA?**  DIPA is a whole-of-government collaboration of over 20 Australian agencies that is maximising the use and value of government administration and transactional data assets.[[103]](#footnote-104) DIPA is doing this by improving technical data infrastructure and data integration capabilities across the Australian Public Service (APS). DIPA ensures the privacy and security of sensitive data is preserved by providing access only to controlled, de-identified and confidentialised data for policy analysis and research.  DIPA is composed of several components including:   * data infrastructure and integration * data assets * data analytical units * communication and engagement on data initiatives * technical review and advice.   Individual agencies are responsible for the delivery of their individual components. A Deputy Secretary-level DIPA Board provides strategic oversight and coordination and reports to the Secretaries’ Data Group. |
| --- |

A large amount of innovation-related research and analytical work has also been progressed by Australian Government agencies outside the purview of DIPA and BLADE, including:

* The Department of Education’s ‘uCube’, which provides access to multi-dimensional time series data based on selected data collected through the Higher Education Statistics Collection[[104]](#footnote-105)
* The DESSFB’s ‘Labour Market Information Portal’ (LMIP), which publishes industry and employment trends based on research in the areas of skill shortages, recruitment experiences, labour and skills needs.[[105]](#footnote-106)

The ABS has also enhanced the value of census data through data integration to leverage more information from the combination of individual datasets than is available from the separate datasets. For example, the ABS has linked Census data with data from the Department of Home Affairs on migrant settlement and temporary entrant visa holders. [[106]](#footnote-107),[[107]](#footnote-108)

### Analysis undertaken by state and territory governments

The focus of innovation-related analysis and research undertaken by state and territory government agencies is on understanding innovation activity and impacts at the state and territory level, and sometimes in smaller areas, to provide an evidence base for state and territory-based programs and initiatives.

The NSW Innovation and Productivity Scorecard is an example of a state-based innovation system reporting mechanism, and is discussed further in Chapter 1.[[108]](#footnote-109) This analysis is meeting a demand not generally met through other means, since there is limited state and territory-level innovation-related information currently available.

### Analysis undertaken by academia

The academic community is an important source of knowledge and analytical capability and a significant contributor to innovation-relevant research.

With regard to the Australian Government’s BLADE projects, a number of academic institutions have been involved, including the Australian National University (ANU), Swinburne University of Technology, the University of New South Wales (UNSW), and the University of Technology, Sydney (UTS). There is an opportunity for Australian governments to enhance the effectiveness of academic capability through improved access to the data held by Australian governments, as discussed later in Chapter 4.

### Analysis undertaken by private sector

The digitalisation of data globally is changing the data landscape and presenting new opportunities for analysis. There are an increasing number of private sector organisations who have access to data that could be valuable for public good purposes. Many of these organisations may be interested in making information available to Australian governments. The *Proceedings from the Innovation Metrics Review Workshop* (at Appendix D) discusses policy-relevant innovation related research and analysis that is being undertaken by the private sector.[[109]](#footnote-110)

### Analysis undertaken by international organisations

Various international organisations undertake analytical work to contribute to evidence needed by policymakers to inform decision-making. Organisations such as the OECD undertake analysis work that often involves cross-country studies to complement national level studies. A range of OECD work is engaging with (sometimes confidential) business-level data across OECD countries to explore innovation and productivity performance. Such cross-country analysis can complement national studies, as national studies alone cannot identify whether findings for a particular country are only applicable for that country or part of a broader pattern. For example, ongoing OECD work on R&D tax credits, covering more than 20 countries (including Australia), has identified new patterns in the role of R&D tax credits and direct support across countries.[[110]](#footnote-111)

## Barriers exist to progressing research and analysis

The Review found some common themes across different stakeholders in relation to barriers that prevent or limit innovation-related research and analysis from being undertaken.

### Coordination of research and analysis is lacking

While there has been Australian Government progress in regards to innovation-related research and analysis, because responsibilities are split across agencies, analysis work is largely progressed based on individual agency needs and resource availability, although the DIPA process means projects using BLADE are coordinated and prioritised between participating agencies. Often these activities are undertaken without a national view of priorities. In addition, there are limited channels for stakeholders to communicate data and research needs, and to coordinate and set whole-of-government research priorities.

While DIPA (Box 3.3) provided some initial investment to improve the data infrastructure for research and analysis, ongoing investment is required to maintain and improve the capability of infrastructure, including making analytical tools available to researchers. Existing innovation datasets are currently linked according to the priorities set by DIPA. These priorities are set on a whole-of-government basis and there is no prioritisation of projects outside the purview of DIPA.

### Limited engagement with the OECD and other international bodies is reducing the opportunity for Australia to leverage international work

There is an incentive for individual agencies to reduce costs by limiting their engagement in international work. This means that Australia is not being quick to leverage international work of relevance to Australian issues, and is not contributing its experiences to cross-country studies. The Review identified some Australian innovation measurement issues that should have been addressed before now in the light of international experiences (such as the importance of comparable reference periods), and instances where Australian involvement could have added value more broadly (for example, by stressing the importance of non-R&D innovation expenditure, where lack of visibility of this issue in some countries has impacted on the OECD’s ability to attract funding to undertake work in this area).

### Lack of visibility and access to innovation-related data sources is a barrier to analysis for many stakeholders

The consultation process highlighted problems related to both visibility and accessibility of innovation-related data sources.

Not all government datasets are visible or accessible to analysts, or even to government analysts in the same level of government, i.e. Australian, state or territory, and sometimes even within the same organisation or entity. Consequently, an enormous amount of existing data is not being utilised for analysis because analysts are not aware that the data exists or they are unable to obtain the data.

Limited access to linked datasets, e.g. via BLADE, and to unlinked government administrative datasets, are hindering data analysis, thus limiting the value of this data for policy and program design and evaluation. For example, analysis undertaken by universities and researchers is limited by current restrictions on accessing BLADE. This is reflected in the low number of academic institutions that are involved in BLADE projects.

Additionally, there are a limited number of state and territory government agencies utilising data integration tools, such as BLADE. State and territory government users require a greater focus on geographical location.

The Productivity Commission’s public inquiry on data availability and use suggested that there was a large potential for data linkage and integration at the Australian level that had not been realised due to complex efforts required to work around conflicting legislative and internal policy requirements.[[111]](#footnote-112)

Access to ABS microdata has been streamlined in the past 12 months to deliver more timely access in a safe and secure way. In March 2019, the ABS implemented non-secondment access to BLADE microdata for government employees, government contractors, and individuals sponsored by government departments for approved projects. Some stakeholders are still unaware of this and there would be merit in promoting it further through the academic community.

There are trade-offs being made in relation to the increased value of data that is shared for use in additional analysis and the need to limit access to protect the rights of those that supply it and the integrity of the data, given that many of the government datasets that analysts seek access to are sensitive in nature. This is a complex issue, expected to be addressed by new legislation in the near future.

### Limited analytical capability and capacity to undertake research and analysis on innovation in the government sector

There is limited analytical capability and capacity to undertake research and analysis in the government sector.

More analysis is needed, but there is a lack of people with the skills to perform it. Data inaccessibility is causing a ‘chicken and egg’ problem with regard to analysts, both within and outside of the government sector – analysts are unable to gain access to innovation-relevant data and are therefore not able to develop the skills needed to analyse the data.

This also impacts upon the pool of skilled analysts that are able to provide training on how to analyse innovation-relevant data. For analysts who have developed digital capability and mathematical skills in other fields, there is no clear pathway to develop innovation-relevant data analysis skills.

## A whole-of-government approach to research and analysis is needed

| **RECOMMENDATION 3.1: TAKE A WHOLE-OF-GOVERNMENT APPROACH TO INNOVATION RESEARCH** |
| --- |
| The responsible entity should take a whole-of-government approach to innovation research, drawing on capabilities across Australian, state and territory government agencies, academia and the private sector.  The aim would be to build strong analytical capability regarding of Australia’s innovation ecosystem. |

### Ongoing investment is needed to provide infrastructure with sufficient capability and capacity to support research

While DIPA provided for some initial investment to improve the data infrastructure for research and analysis, ongoing investment is required to maintain and improve the capability and capacity of infrastructure to support research, including making analytical tools available to researchers.

### Analysis and research of innovation-relevant data is essential to inform policy decisions.

There is a need to progress policy research and analysis to address   
whole-of-government innovation-relevant information priorities effectively and efficiently.

To do this, the following is needed:

* ability to identify whole-of-government innovation-related research and analysis requirements, and their relative priorities
* access and visibility of the innovation-related data sources to support research and analysis
* ability to enhance the analytical value of data sources and statistical assets
* a critical mass of analytical capability, capacity and development to undertake research and analysis.

### Ability to identify whole-of-government innovation-related research and analysis requirements and their relative priorities

As the Review has established, there are a large number of stakeholders and users of innovation-relevant data, analysis and research. A coordinated approach would enable the Australian Government to identify whole-of-government requirements and to draw on capabilities across Australian, state and territory government agencies, academia and the private sector to create a critical mass of resources and analytical capability.

In addition, many of the identified information gaps and emerging data and analysis needs are not unique to Australia. There may be opportunities to collaborate internationally to develop solutions.

### Access to and visibility of innovation-relevant data sources to support research and analysis

Existing innovation datasets are currently linked according to the priorities set by DIPA. There is no whole-of-government prioritisation of projects outside the purview of DIPA. There is a need to establish a process for prioritising access to innovation datasets. The datasets of greatest value for innovation measurement should be available for integration through tools such as BLADE.

Preparing data for integration to ensure the privacy and confidentiality of sensitive data is protected is a costly process. Not all government administrative and transactional data are considered valuable enough to warrant such treatment. However, the potential gains from integrating the more valuable datasets – such as the trade data that has recently been added to BLADE – are large enough to justify incurring such costs.

### Ability to enhance the analytical value of data sources and statistical assets

There is an opportunity to leverage existing official statistical assets, such as BLADE (Box 3.2) and the LLEED (Box 3.3).

The analytical utility of BLADE could be enhanced through integration of additional appropriate data sources and the inclusion of location-based data where possible.

There would be merit in allocating resources specifically to enhance the analytical value of innovation data sources through making them more accessible.

Similarly, LLEED is of considerable analytical value, particularly in understanding the innovation system, linkages and impacts. Accelerating the development of LLEED would be of significant value to further inform the understanding of ‘human capital’ in innovation, and of the locational impacts of innovation.

**There are also opportunities to present existing data in new ways.**

The Review has also identified opportunities to present existing data in new ways, to provide a more complete picture of innovative activities and their impacts.

Australia currently collects business innovation indicators through the BCS.[[112]](#footnote-113) This is a large omnibus collection of questions designed for different purposes, some of which are administered annually and some every two years. Internationally, some countries have developed ’innovation profiles’ using ‘Community Innovation Survey’ [[113]](#footnote-114) data (the European equivalent of BCS data) to provide deeper insight on the styles and modes of innovation and innovative capabilities within businesses, industries and the broader economy.[[114]](#footnote-115) The profiles determine if businesses are ‘strategic’, ‘intermittent’, ‘adaptive’ or ‘adoptive’ innovators. As highlighted by Arundel et al. (2019), ‘innovation profiles might explain much better different innovation performances of economies – and would point more precisely to different policy measures that would be effective to increase it in each context’.[[115]](#footnote-116) Australia could undertake similar analysis using existing BCS data – with no increase in provider burden – to enable new insights into the innovative behaviours of Australian businesses.

**There are emerging opportunities to analyse alternative sources of data.**

As highlighted in Chapter 2, there are an increasing number of private sector organisations who hold data that could be valuable for public good purposes and who may be interested in making information available to Australian governments at a summary level. In general, such businesses are not willing to share the records of individuals or businesses – to protect customer privacy and confidentiality – but are willing to share aggregates or run programs and the findings of specific analyses conducted for public good reasons, sometimes as a public service and sometimes for a fee.

**There are also opportunities to use existing data to provide benchmarking tools**

System level benchmarking tools, such as the Scorecard, are an effective mechanism for comparing the broader performance of aspects of the innovation system.

However, system level benchmarking tools are of limited use for individual businesses wanting to know how they are performing in comparison to others in the same sector and of similar size. There are opportunities to engage directly with the business sector about innovation using existing data to provide benchmarking tools. This has been a focus in many other countries, including in Canada, where the Government implemented a report builder that is able to compare the financial data of a particular business with industry averages.[[116]](#footnote-117) A similar innovation performance benchmarking toolkit for Australia could benefit businesses by helping them to understand:

* how their innovation activities and other characteristics compare to others in their sector or of their size
* government support that they may be eligible to receive.

In addition, benchmarking tools can be useful to incentivise businesses to keep records and report on their innovation activities.

Recent research by BizLab in DIIS found that businesses could benefit from the use of such benchmarking tools, particularly if they are easy to find and well-publicised amongst those that commonly advise businesses, such as accountants.[[117]](#footnote-118)

### A critical mass of analytical capability and capacity

There is a shortage of skilled analysts available in the government sector to undertake the analytical work required, in terms of both capability and capacity. There is, however, a large amount of analytical capability, skill and knowledge available in academia and the private sector. Greater cooperation with university and the private sector could help provide the critical mass needed to progress research and analysis. This would also provide a channel for innovation stakeholders to transfer knowledge, communicate data and research needs, and respond to and influence whole-of-government research priorities.

A coordinated approach to innovation research would also create a critical mass of resources, including infrastructure development, through leveraging capabilities across Australian, state and territory government entities, academia and the private sector.

This could also be a function of the lead entity with regard to the measurement of the Australian innovation ecosystem (see Chapter 4).

# 4. Leadership on innovation measurement

|  |
| --- |
| Key points   * There are a large number of stakeholders and users of innovation data across Australian, state and territory government agencies, the research and academic communities, and the private sector * Stakeholders are playing important roles in measuring and monitoring Australia’s innovation system, and each has different – and sometimes competing – needs * At present, there is no single body with responsibility for leadership on innovation measurement in Australia. As a result, the innovation measurement system is fragmented * A lack of a coordinated approach to innovation measurement in Australia makes the development of a national strategic approach to measuring innovation difficult and unnecessarily resource-intensive * As the Australian economy continues to change and develop, new requirements for data, metrics, and analysis of issues relevant to innovation are emerging. Strong leadership will make it easier and cheaper to meet these needs by reducing the costs of transitioning to new ways of working * National leadership on innovation measurement is therefore needed to establish priorities and timeframes to address key innovation measurement issues. |

## There are a large number of innovation measurement system stakeholders with differing and competing priorities

There are many stakeholders playing important roles in measuring and monitoring Australia’s innovation system. Stakeholders and users of innovation data are spread across Australian, state and territory government agencies, the research and academic communities, and the private sector, each having different and sometimes competing priorities. For example, stakeholders have relationships ranging from supply and use of innovation-related data, research and analysis, and delivery and evaluation of innovation-related policies and programs. In reality, however, these interactions and relationships are much more complex.

Each of these stakeholders have responsibility for measuring key areas of the innovation ecosystem. However, their roles, needs and priorities can differ substantially, and are sometimes competing. The following section provides an overview of the roles of some of the key innovation system stakeholders.

### Australian Government agencies

Table 4.1: Australian Government agencies

| **Australian Bureau of Statistics (ABS)** | |
| --- | --- |
| Description | The ABS is Australia’s national statistical agency, providing trusted official statistics on a wide range of economic, social, population and environmental matters of importance to Australia. |
| Key role(s) | **Collection and dissemination of key innovation related data**   * The role of the ABS includes providing statistical information, and coordinating and advising official bodies on statistics, including developing – and ensuring compliance with – statistical standards * The ABS carries out a number of activities for measuring innovation in Australia. These include conducting key national surveys designed to collect data on innovative activity in Australian businesses, such as the suite of Research and Experimental Development surveys, the BCS, and the VC&LSPE Survey.   **Data integration**   * As an Accredited Integrating Authority, the ABS has a key role in DIPA to combine public data, as authorised by law, provide access to authorised users and expand existing Australian data integration projects to include new data, including the Multi-Agency Data Integration Project (MADIP), and BLADE.   **Research and analysis**   * The ABS conducts research and analysis across a range of topics related to innovation.   **International reporting**   * The ABS has international reporting obligations with international bodies, such as the OECD, International Labour Organization (ILO), and the United Nations, Educational, Scientific and Cultural Organisation (UNESCO). |

| **Department of Industry, Innovation and Science (DIIS)** | |
| --- | --- |
| Description | DIIS is the Australian Government agency responsible for innovation policy.  Portfolio agencies include:   * Australian Nuclear Science and Technology Organisation (ANSTO) * Commonwealth Scientific and Industrial Research Organisation (CSIRO) * Geoscience Australia * IP Australia * National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) * Northern Australia Infrastructure Facility (NAIF). |
| Key role(s) | **Innovation policies and programs**   * DIIS has responsibility for a number of key innovation policies and programs, including the Research and Development Tax Incentive (RDTI), Entrepreneurs Program, Industry Growth Centres and Cooperative Research Centres (CRC) * DIIS needs quality measures to be able to evaluate the impacts and effectiveness of its policies and programs.   **Collection of innovation related data**   * Through delivery of its programs and other functions, DIIS collects data that can be used in evaluation, research and analysis * DIIS produces the Science, Research and Innovation Budget Tables and the NSRC.   **Innovation system performance monitoring**   * Since 2010, DIIS has been publishing the annual *Australian Innovation System Report* (now the *AIS Monitor*). The publication brings together a body of evidence on the structure and performance of Australia’s innovation system, based on a range of key indicators from new and existing sources. The Monitor explores the impact of innovation on business, industry and national performance, and also outlines challenges and future opportunities for Australian innovation.   **Research and analysis**   * DIIS conducts research and analysis across a range of topics related to innovation to provide an evidence base for development and evaluation of policy and programs.   **Data Integration Partnerships for Australia (DIPA)**   * DIIS has a leadership and coordination role with regard to the Economic Data and Analysis Network (EDAN) which is funded under DIPA. |

| **Innovation and Science Australia (ISA)** | |
| --- | --- |
| Description | Innovation Science Australia (ISA) is an [independent statutory board of entrepreneurs, investors, researchers and educator](https://www.industry.gov.au/strategies-for-the-future/innovation-and-science-australia/innovation-and-science-australia-board)s which has a whole-of-government remit on innovation.  Under the Industry Research and Development Act 2016, ISA has responsibility for providing independent strategic advice to the Secretary, the Minister and other Ministers in relation to innovation matters. Under the Act, ISA is also required to do anything incidental or conducive to the performance of its legislated functions, and may receive written directions from the Minister with portfolio responsibility for ISA. These written directions are delivered to the ISA Board via a Statement of Expectations, to which ISA responds with a Statement of Intent.  While ISA has a whole-of-government remit on innovation matters, its role currently does not include providing leadership on innovation measurement. |
| Key role(s) | **Innovation system performance monitoring**   * ISA has published two key documents with relevance for innovation measurement, namely the Performance Review of the Australian Innovation, Science and Research System (2016), and Australia 2030: Prosperity through Innovation, a national roadmap to strengthen Australia’s ability to innovate (2018) * Through the above publications, ISA has developed scorecards to monitor the performance of the Australian innovation system, drawing on metrics and data from a range of sources.   **Research and analysis**   * ISA commissions research across a range of topics related to innovation to enable it to provide strategic advice related to innovation matters. |

| **Department of Education and Training (DET)** | |
| --- | --- |
| Description | DET is the Australian Government agency responsible for national policies and programs related to early child care and childhood education, school education, higher education, international education and research. |
| Key role(s) | **Innovation policies and programs**   * DET needs to be able to evaluate the impacts and effectiveness of its policies and programs.   **Collection of innovation related data**   * Through delivery of its programs, DET collects data that can be used in evaluation, research and analysis * DET is responsible for the Higher Education Research Data Collection (HERDC).   **Research and analysis**   * DET conducts research and analysis relevant to education, skills and training, and the role of higher education in the innovation system.   **International reporting**   * DET has international reporting obligations with regard to the OECD.   **Data Integration Partnerships for Australia (DIPA)**   * DET is a Member of the Social Health and Welfare Analytical Unit (SHWAU), which is funded under DIPA. |

| **IP Australia** | |
| --- | --- |
| Description | IP Australia is the Australian Government agency that administers IP rights and legislation relating to patents, trademarks, designs and plant breeders’ rights. |
| Key role(s) | **Collection of innovation-related data**   * Through service delivery, IP Australia collects and disseminates key innovation-related data, e.g. IP Government Open Data (IPGOD) and IPLORD.   **Research and analysis**   * IP Australia conducts research and analysis to enable it to contribute to the innovation system more broadly by providing advice to government and Australian businesses to make the most of their IP.   **International engagement**   * IP Australia works with the World Intellectual Property Organization (WIPO) and a range of international agencies to build and strengthen the IP rights system.   **Data Integration Partnerships for Australia (DIPA)**   * IP Australia data are linked to BLADE. |

Other key Australian Government stakeholders to the innovation measurement system include (but are not limited to):

* Agencies with a whole-of-economy perspective on the impacts of innovation, such as Treasury and the Productivity Commission
* Agencies with more focused perspectives on the impacts of innovation such as: the Department of Defence; the Department of Communications and the Arts; the DESSFB; and the Department of Infrastructure, Transport, Cities and Regional Development
* Research agencies, such as the CSIRO and Geoscience Australia
* Research Councils, such as the Australian Research Council (ARC) and the National Health and Medical Research Council (NHMRC).

### State and territory government agencies

Table 4.2: State and territory government agencies

| **State and territory government agencies** | |
| --- | --- |
| Description | A number of state and territory government agencies carry out various innovation measurement activities. These activities are carried out by government departments directly or via specific agencies that are designated to undertake innovation related activities. |
| Key role(s) | **Innovation policies and programs**   * Delivery and evaluation of state and territory government innovation policies and programs.   **Collection of innovation-related data**   * Collection of innovation-related data through program delivery.   **Innovation system performance monitoring**   * State and territory government agencies carry out various innovation measurement activities. For example, the New South Wales (NSW) Innovation and Productivity Council provides a snapshot of the state’s innovation and productivity performance in comparison to other states and selected international economies.[[118]](#footnote-119)   **Research and analysis**   * State and territory level agencies also undertake research and analysis. For example, LaunchVic is Victoria's start-up agency that was established by the Victorian Government in March 2016 as an independent agency responsible for developing Victoria's start-up ecosystem. The agency undertakes research in relation to the start-up ecosystem in Victoria. * South Australian and NSW already have some BLADE access to facilitate research and analysis, and the Queensland Government was arranging access at the time this report was being finalised to facilitate research and analysis work by the Queensland University of Technology staff. |

### Academic and research community as well as the private sector

Table 4.3: Academic and research community and the private sector

| **Universities** | |
| --- | --- |
| Description | As a key part of the research system, universities play a role in both the supply of data and in conducting research and analysis. |
| Key role(s) | **Data supply**   * Universities provide data to some key innovation-related collections such as HERDC and the R&D survey.   **Research and analysis**   * A significant amount of innovation-related research is conducted by the academic and research community across a range of topics. |

| **Private sector** | |
| --- | --- |
| Description | The private sector is also a significant part of the innovation ecosystem, with businesses being the unit of measurement for a number of innovation metrics. |
| Key role(s) | **Data supply**   * Businesses provide data to some key innovation-related collections, such as the BCS and the R&D survey.   **Collection of innovation-related data**   * There are private sector organisations that collect innovation-related data through service delivery.   **Research and analysis**   * A number of private sector organisations also contribute to innovation-related research and analysis. |

| **Organisation for Economic Cooperation and Development (OECD)** | |
| --- | --- |
| Description | The OECD is an international organisation that provides a knowledge hub for data and analysis, exchange of experiences, best-practice sharing, and advice on public policies and global standard-setting. |
| Key role(s) | **Measurement frameworks**   * The OECD has developed international frameworks for the measurement of innovation-related subjects (e.g. the Oslo Manual and the Frascati Manual).   **Collection and dissemination of innovation-related data**   * The OECD collects and publishes innovation data from member countries. Key publications include the STI Scoreboard and the MSTI.   **Innovation system performance monitoring**   * Vis its publications, the OECD enables international comparison of innovation indicators.   **Research and analysis**   * The OECD conducts a significant amount of analysis related to innovation across a range of topics. |

## Responsibility for measurement of the Australian innovation system is fragmented

The policy and research communities which shape the demand for innovation indicators are becoming more diverse and sophisticated. While innovation is a core issue for economic development, it is also a whole‐of‐government issue and relevant to all areas of administration and policy.[[119]](#footnote-120)

Responsibility for Australia’s innovation measurement system is currently split across Australian, state and territory government agencies, and the ABS.

At present, there is no single body with responsibility for leadership on innovation measurement in Australia. As a result, the innovation measurement system is fragmented, and Australia’s understanding of international measurement developments is limited.

Lack of leadership poses a number of issues for the measurement of innovation:

* Decision-making is occurring in silos, with stakeholders focused on progressing their own needs without taking a whole-of-government perspective into account. The fragmented nature of the system is not aiding appropriate prioritisation or development of a national strategic approach to measurement of innovation, therefore, the current innovation measurement system is not functioning as well as it could
* As the Australian economy continues to change and develop, new requirements continue to emerge. There is currently no system to establish priorities to address new and emerging information gaps relating to innovation
* There is a lack of coordination across the innovation measurement system. The OECD has observed high personnel rotation in what should be in principle stable roles and the challenges arising from restrictions to participation in OECD meetings. A key issue for the OECD (and other international entities) is that there is no easy way for them to identify which entities and staff should be contacted as part of international engagement regarding measurement of innovation
* The OECD is keen for Australia to engage with the international community with regard to innovation, science and technology measurement. At present, Australia’s involvement in international work has been limited
* Similarly, there is no single point of contact – or even a single starting point – for international engagement on innovation measurement. The Review found several instances where international entities had inadvertently cited old data or incorrectly said that Australian data was not available, because the researchers compiling international data did not know where to look for the most recent and relevant Australian innovation data. Frequent machinery of government changes and changes of roles make Australian innovation ecosystem measurement responsibilities largely opaque to international researchers. This, in turn, impacts on Australia’s access to valid international comparisons.

## International examples of leadership of innovation measurement

Australia is not the only country grappling with providing leadership on innovation measurement. Other countries also seem to have fragmented responsibilities and accountabilities in this regard. There are some countries that have an established leadership (or even partial leadership) of innovation measurement. Different leadership examples in the US, the United Kingdom (UK) and Germany are discussed below. The entities in these examples support, coordinate and provide leadership for innovation measurement (albeit to varying degrees).

### The United States

The National Science Foundation (NSF) is an independent US federal agency whose mission includes support for all [fields of fundamental science and engineering](https://www.nsf.gov/funding/aboutfunding.jsp), except for medical sciences.[[120]](#footnote-121) It is the only federal agency with a whole-of-government remit. The NSF supports scientists, engineers and educators directly through their own home institutions.

The policies of the NSF are set by a 24 member National Science Board (NSB) within the framework of applicable national policies set forth by the President and the Congress. The NSB identifies issues that are critical to NSF's future and approves NSF's strategic budget directions. Among its functions, the NSB publishes a biennial report, Science and Engineering Indicators (Indicators), which provides comprehensive, policy-neutral information on the nation’s science and engineering enterprise. In addition to the main report, the NSB produces a suite of [related resources](https://nsf.gov/nsb/sei/index.jsp).[[121]](#footnote-122)

The National Center for Science and Engineering Statistics (NCSES) was established within the NSF. Its mandate is the collection, interpretation, analysis, and dissemination of objective data on the U.S. science and engineering enterprise.[[122]](#footnote-123) As one of 13 federal statistical agencies, NCSES designs, supports, and directs periodic national surveys and performs a variety of other data collections and research. Other agencies collecting innovation related information include the Bureau of Labor Statistics (BLS), the Census Bureau, the BEA, the National Institute of Standards and Technology (NIST), and the Economic Research Service at the Department of Agriculture. The National Center for Education Statistics is also relevant as it collects data on STEM education and publishes comprehensive information on education in its ‘Digest of Education Statistics’.

### The United Kingdom

The UK has separate entities that are responsible for leadership on innovation matters. UK Research and Innovation, together with its research councils, work in partnership with universities, research organisations, businesses, charities, and government to create the best possible environment for research and innovation to flourish.[[123]](#footnote-124) Measurement of innovation is conducted by government departments, including the Department of Business, Energy and Industrial Strategy (BEIS). The UK Innovation Survey[[124]](#footnote-125) is conducted on behalf of BEIS by the Office for National Statistics.

The leading thinking on innovation measurement in the UK continues to be from the National Endowment for Science, Technology and the Arts (Nesta). Established in 1998 as a Charity, Nesta is an innovation foundation that acts through a combination of programmes, investment, policy and research, and the formation of partnerships, to promote innovation across a broad range of sectors.

Recent work undertaken by Nesta includes development of new ways to use UK administrative data to map innovation activity in Wales. Nesta has also used the data for sectoral mapping analysis, as defined with high level groupings of industry code data. The outputs of this work, ‘Arloesiadur is an innovation dashboard for Wales’, which is a collaboration between Nesta and the Welsh Government. Nesta has used the new data to measure and visualise Wales’ industry, research, and tech networks with the goal of informing policies that drive growth.

### Germany

Germany’s approach to leadership on innovation measurement is undertaken by the Commission of Experts for Research and Innovation (EFI). The EFI advises the German Federal Government on innovation performance in Germany.

A key task for EFI is to provide a comprehensive analysis of the strengths and weaknesses of the German innovation system in an international context, based on latest comparison data. It also coordinates the priority and indicator studies of the involved scientific institutions and integrates its key findings into commission reports.[[125]](#footnote-126) Furthermore, Germany's perspectives as a location for research and innovation are evaluated on the basis of the latest research findings. The EFI also presents proposals for national research and innovation policy, including the presentation of an annual report.

EFI members are appointed by the German Government, however the EFI is independent in its action.[[126]](#footnote-127)

### An opportunity for Australian leadership

The experience in other countries, and the feedback received through the Review, suggests that the Australian model, and indeed most models, are insufficient to coordinate the measurement of innovation well. In general, responsibility and accountability are split between too many parties for best results.

## Assigning responsibility for leadership on innovation measurement

| **RECOMMENDATION 4.1: ASSIGN RESPONSIBILITY FOR LEADERSHIP OF INNOVATION MEASUREMENT** |
| --- |
| Appoint a single entity with a whole-of-government remit, to provide national leadership for innovation measurement and reporting.  This leadership role will entail:   * collaborating with stakeholders to identify and address data and metrics gaps, and ensure the continued relevance of innovation data and metrics taking into account Australia’s changing economy, society and environment * reporting to the Australian Government on the progress of the implementation of recommendations proposed in this Review * ensuring Australia is represented in international efforts to improve innovation, science and technology measurement * being a single point of contact to facilitate international engagement on innovation measurement issues * allocating work through contract management to enable it to perform these functions.   This leadership role will not entail:   * collecting data directly * conducting research directly.   The entity would collaborate with the ABS to ensure new data and metrics were consistent with international work where appropriate. |

A single entity could be assigned responsibility to provide national leadership of innovation measurement and reporting. The complexity of the innovation system necessitates that the responsible entity has a whole-of-government remit.

The responsible entity would also report annually on the performance of the innovation ecosystem in Australia as part of an innovation metrics scorecard (see Chapter 1).

Assigning responsibility for leadership to a single entity would provide significant benefits, such as:

* enabling Government to develop a more efficient, strategic national approach to innovation measurement
* improving collaboration amongst innovation system stakeholders
* ensuring that data gaps in key areas of the innovation system are addressed
* ensuring that new and emerging data needs are identified and addressed as the economy continues to evolve
* providing a single point of contact for tracking and reporting on the internationally comparable performance of Australia.

With regard to the single point of contact function, it is not envisaged that this entity would have all current innovation data available for dissemination. Rather, it should know where the data are kept and which organisational unit in each particular entity should be contacted to obtain access to the most recent and relevant data.

# Roadmap for change

|  |
| --- |
| Key points   * The roadmap for change discusses issues in relation to the priority and timing of the implementation of recommendations * It also discusses future work that was beyond the scope of this Review but could usefully be undertaken in future. |

## Implementing the recommendations of the Review

The Review has made a number of recommendations to improve the measurement of the Australian innovation ecosystem, as listed earlier in this Report. However, they are not all of equal priority or equally time-sensitive.

### Relative priority of recommendations

There are recommendations that have a very high priority. This is due to them having high expected returns on investment on information infrastructure for Australia if the outcomes of those recommendations are delivered.

These recommendations include the responsibility for leadership on innovation measurement (Rec. 4.1) and annual innovation system reporting (Rec. 1.1) that are necessary for the proper implementation of other recommendations. Others are opportunities to change the measurement of the innovation landscape significantly for the better, namely:

* a standalone Australian Business Innovation survey (2.3)
* improving measures of intangible capital (Rec. 2.7)
* annual R&D measures of expenditure (Rec. 2.1)
* measures of business use of digital technologies (Rec. 2.2)
* measuring digital activities in the economy (Rec. 2.8)
* taking a whole-of-government approach to innovation research (Rec. 3.1)
* sectoral analyses (Rec. 2.4)
* measuring government acquisition of innovation (Rec. 2.9).

The two recommendations on classifications review (ANZSCO and ANZSIC) are a high priority. They are both large, complex recommendations that would be expensive to implement. Nevertheless, the expected benefits to the innovation measurement system as a result of their implementation are expected to be large, through supporting better analysis. The ANZSIC review (Rec. 2.6) is the only recommendation that should not be commenced immediately, if supported. Instead, it should be commenced a year after the commencement of the ANZSCO review (Rec. 2.5). The ANZSCO review is the higher priority of the two recommendations and it will be easier to implement than the ANZSIC review, which is a much larger job.

If the ANZSCO review commences a year prior to the ANZSIC review, it is expected that the ABS will be able to use staff who have acquired skills during the development phase of the ANZSCO review to conduct the development phase of the ANZSIC review. It is therefore recommended that these commence a year apart, with the ANZSCO review occurring earlier.

The Review’s remaining recommendations indicate the direction required to improve the measurement of Australia’s innovation ecosystem. Further work will be required in these areas after they have been implemented to optimise innovation measurement, namely:

* measures of entrepreneurship (Rec. 2.10)
* business access to finance for start-ups (Rec. 2.11)
* location-based innovation (Rec. 2.12)
* research commercialisation (Rec. 2.13).

The relative priorities of the recommendations are outlined at Appendix J.

### Assessment of the potential impact of the Review’s proposed recommendations

The Review has made an assessment of the current state of a wide range of data and metrics that are relevant to innovation measurement and are heavily used in policy and program development, implementation and evaluation (see Figure 5.1). Data and metrics that had no issues identified with them that would affect their use were assessed as ‘green’. Those with some measurement issues were assessed as ‘orange’. Those with significant measurement issues were assessed as ‘red’. The Review has the expectation that the successful implementation of its recommendations will greatly improve the status of innovation-related data. Figure 5.1 summarises these expected changes.

Figure 5.1: Assessment of Australian innovation system data

| Figure 5.1 (page 99) is a stylised table that shows the assessment of Australian innovation system data. Assessments have been made for the innovation ecosystems characteristics of: intangible capital, digital activities in the economy, government acquisition of innovation, research commercialisation, industry and occupation classifications, location-based innovation, entrepreneurship, business access to finance, business innovation activities, collaboration, business use of ICT, expenditure on R&D, business grants, patents granted and business entries. These assessments have been made in the present state as well as the future state envisioned by the Review upon successful implementation of all recommendations. The table shows a marked improvement in the state of innovation system data upon implementation of the Review’s recommendations. However, it also shows that ongoing work will be required. Some items marked red (as being in a state which is of concern) move to yellow (improved, but still not entirely satisfactory) rather than green (satisfactory). This reflects the difficulty of measuring intangible capital, digital activities in the economy, and Government acquisition of innovation well. |
| --- |

### Which recommendations should be implemented as soon as possible

Two of the high priority recommendations are time-sensitive, as they leverage existing work by the ABS. These are the measurement of business innovation activities (Rec 2.3) and the measurement of business use of digital technologies (Rec 2.2).

If a decision is made to fund the implementation of the measurement of business innovation activities recommendation by October 2020, it is expected that the ABS will be able to develop a collection to be conducted in relation to the 2019–21 reference year. (The utility of this collection is likely to be maximised by a decision in May rather than in October 2020, given the load on the ABS in the lead-up to the 2021 Census.) This will lead to more relevant innovation data being published by mid-2022. If a decision is made to support this recommendation later than this, more relevant data may not be available until 2024, as this aligns the timing with OECD reporting of innovation indicators.

Business use of digital technologies is collected by the BCS, with the next release of these indicators scheduled for mid-2021. A decision to fund the implementation of the measurement of business use of digital technologies recommendation by May 2020 would provide the opportunity to produce more granular estimates against relevant indicators by mid-2021.

Funding the measurement of business use of digital technologies recommendation will also support the development and release of richer indicators, beyond what is provided in mid-2021, from mid-2023.

### Further work

**Assessing a wider range of innovation impacts**

This Review concentrated on the economic impacts of innovation, as specified in its scope. Over the course of the Review, it was established that innovation is an important tool that is used to address a wider set of objectives. As highlighted in ATSE’s literature review (see Table 2 of Appendix E), in addition to economic objectives and benefits, there is demand for relevant innovation indicators relating to the following impacts:

* Environmental – responding to climate change, the need for sustainable use of natural capital, water and energy
* Health and wellbeing – healthy aging and workplace health and safety
* Social – inclusion, addressing inequality and other issues (e.g. problem gambling).

Increasing interest in understanding and assessing a wider range of benefits of innovation warrants multiple approaches to measurement and indicators. However, connecting measures of innovation to economic and social outcomes is often even more challenging than quantifying innovation or its inputs.[[127]](#footnote-128)

The OECD has a substantial program in environmental innovation policy and assessment (see Section 8.3 of Appendix E). The literature review also highlights a number of major projects that have contributed to the body of knowledge relating to environmental innovation. It also acknowledges that the development and implementation of a reasonably comprehensive set of indicators for eco-innovation will be demanding.

Despite those areas being beyond the scope of the Review, the Review’s consultation process indicated there is demand from stakeholders to better understand the environmental, health and wellbeing, and social impacts of innovation. Further work in this area could usefully be undertaken.

**Public sector innovation**

Public sector innovation is an important area of innovation research that fell beyond the scope of this Review. In OECD countries, including Australia, the public sector contributes over 20 percent of GDP – too large a sector to ignore in terms of innovation.

There has been extensive debate over the past decade on developing indicators for innovation in the public sector that go beyond measures of R&D, with some now feeling there is adequate conceptual and methodological development to design a robust survey approach for public sector innovation in Australia.[[128]](#footnote-129)

It has been proposed that such a survey should share some elements with the Oslo Manual but differ significantly in others. The OECD is consequently considering developing a measurement manual specifically for the government sector.[[129]](#footnote-130) Experimentation with public sector innovation indicators is ongoing, with large-scale surveys in Norway and Denmark, and the European Co-Val survey initiated in February 2019.

This substantial work in the measurement of public sector innovation has been progressed internationally and could be leveraged to provide Australian indicators.

**Innovation data gaps**

The Review also noted data gaps that were that were unable to be investigated further or included in the recommendations due to time or resource constraints. Further consideration should be given to these gaps, in particular:

* Measurement of innovation and diversity

There is a need for improved data and statistics in the measurement of innovation related to diversity (e.g. gender, age and ethnicity) to inform policy development and facilitate business utilisation of potentially underutilised resources. The Review has not made specific recommendations on the additional diversity data to be collected but has identified this as an area for future research, and has summarised the feedback obtained from its consultation process in Chapter 2.

* Measures of workforce skills

There are problems with using qualifications and experience as proxies for skills (see Chapter 2). Skills classification work is currently being undertaken by the DESSFB. The single entity with national leadership of innovation should ensure this work also meets the innovation ecosystem’s need for skills data.

* Management capability

Management capability is a relatively new area of focus for innovation measurement and limited data has been collected and published to measure business management capabilities. Some of this data has proven to be valuable but the relatively high cost associated with the MCM of the BCS has diminished support for administering this particular module again in the same way in the near future. The importance of this data means that other statistical solutions should be considered further.

# Appendix A: Scope of the Review

In embarking upon the Review, the co-Chairs established a guiding set of goals and principles along with the scope of the Review, and these were refined and agreed with the international Steering Committee. The goals and principles appear in the Introduction. The scope is given below.

The Review has several broad objectives:

* To undertake a written international literature Review of different approaches to the measurement of innovation to ensure the Review is conceptually well-grounded and at the forefront of international thinking, tapping into new developments from abroad
* To provide a theoretical framework to underpin the design of data collection to measure innovation in Australia, by first producing a discussion paper and seeking feedback on it from an Expert Group and selected international technical advisers
* To examine the measurement of intangible capital and the extent to which changes in intangible capital are captured in innovation metrics
* To look at the data presently available to support the development of innovation metrics and identify the gaps
* To provide recommendations on what to change about current data collection activity aimed at measuring innovation in Australia from an economic perspective, giving a range of options which would more fully address stakeholder needs, and explaining the benefits and costs of each
* To provide recommendations on better options to replace poor quality metrics, or to cease production of metrics whose quality is so poor they are not worth producing
* To develop a set of assessment criteria to determine what constitutes a good metric
* To identify the best metrics presently available
* To identify the best metrics that would be available (including new metrics) based on the data generated if each of the data development options presented was implemented, and in what timeframe
* To consider the composition of an innovation scorecard that will inform policy development, including metrics that
  + measure innovation activity
  + support international comparability
  + increase the transparency of the extent and nature of innovation activity occurring across different industry sectors.

While the framework adopted will be capable of expansion, given the limited budget and timeframe, the Review will focus on addressing the needs identified in this document and the scoping process.

The Review will explore a range of options, including the establishment of a satellite account for innovation, which would measure the contribution of innovation to the economy, and address known data issues, before developing its recommendations. It will make specific recommendations with regard to, but not limited to:

* international comparisons using innovation data
* DIIS’ NSRC
* ABS’ BCS, the Management Capability Survey (MCS), and surveys of Research and Experimental Development
* DIIS and DET program and transactional data and metrics including the Higher Education Research Data Collection (HERDC)
* the use of non-traditional data sources.

These may include options to redesign or replace current Australian data sources. With regard to more substantive issues that cannot be fully developed in a year, it may propose a road map for further development.

Targeted consultation will be undertaken prior to the preparation of the issues paper to be considered at a workshop on 13–14 March 2019. A public consultation process will be undertaken before the report is finalised.

The Review report will be presented to the Australian Government for its consideration by the end of 2019.

# Appendix B: Sectoral studies

## Purpose

The Innovation Metrics Review (IMR) undertook four sector-based case studies to provide insight on:

* how innovative activities occur across different sectors of the Australian economy
* how current innovation measures are capturing (or not capturing) those innovation activities
* what is possible and practical in measurement of innovation activities
* how measures might be improved to provide a more comprehensive picture of relative innovation performance in all sectors of the Australian economy, and assist policy makers to make evidence-based decisions?

## Background

A key concern highlighted in the project plan for the IMR was that existing metrics and composite indices do not provide comprehensive coverage of innovation performance in all sectors of the Australian economy.

It is widely accepted that innovation is undertaken differently across various sectors of the economy. Innovation activities by their nature are novel and varied. Adding to this, the drivers, innovation ecosystems and regulatory factors that impact on an organisation’s need and ability to innovate differ greatly between sectors.

The extent to which innovation activities are ‘hidden’ from existing innovation metrics is not fully understood. ATSE discusses hidden innovation in its literature review (at Appendix E).

Box B.1: What is hidden innovation?

| Until recently, innovation was conceptualised, defined and measured in terms of what was seen as ‘real innovation’– i.e. primarily technology‐based innovation for manufacturing, involving R&D investment and patenting, from large companies and their internal labs. This encouraged innovation researchers to develop metrics for measuring innovation through input indicators, such as R&D funding, and number of research personnel, and output indicators based on patents and citations (see Appendix E).  This Review defines ‘hidden innovation’ as innovation activity that is not captured in current innovation indicators. |
| --- |

Nesta has suggested that a focus on sectoral innovation indicators, rather than the development of internationally comparable national indicators, is likely to be more successful in measuring hidden innovation. Nesta emphasised that greater recognition of the significance of ‘low innovation’ sectors (sectors that report low levels of R&D as a percentage of GPD, but which may be significant investors in technology) for value creation and employment, and a greater understanding of the real dynamics of innovation in these sectors, would lead to changes in the scope of innovation policy.[[130]](#footnote-131)

There are a number of industries in Australia where such a focused approach to identifying innovation could better measure innovation activity. In both the agriculture and mining sectors, there are processes of creative accumulation based on continuous improvements, and processes of creative destruction when new technologies, capabilities, and actors emerge. Understanding the dynamics of innovation in both sectors will also require an approach that encompasses the role of knowledge flows and external suppliers.

The literature shows that innovation in services, such as health services and finance and insurance services, is much less likely to involve R&D or result in patents than product innovation. Hence, indicators, such as R&D and patents, are increasingly inadequate and can be misleading. Innovation in services is also more likely to be non‐technological in nature and involve organisational and marketing innovations. Trademarks are becoming a more useful indicator than patents. The significance of digital technologies for innovation in services means that businesses’ investment in such technologies might be a good indicator of innovation input effort.

As can be seen in the case studies that follow, the IMR found evidence of hidden innovation in Australia, almost exclusively of the non-R&D variety. In Australia, more businesses invest in non-R&D innovation.[[131]](#footnote-132)

The IMR selected mining and agriculture as sectors to examine because of their importance to the Australian economy. These both export goods, so the IMR selected finance and insurance services, and health services, as examples of the service economy.

The four sectors selected for sectoral studies were:

1. Mining
2. Agriculture
3. Health Services
4. Financial and Insurance Services

### Mining Sector

**Rationale for selection**

* Australia’s mining sector contributed around $151.59 billion of Gross Value Added (GVA) to Gross Domestic Product (GDP) in 2017–18 at current prices (8.20 percent of GDP).[[132]](#footnote-133) The mining sector had revenue of $254.55 billion in 2017–18.[[133]](#footnote-134) The mining sector employed about 227,000 persons full-time and 8,000 part-time as at the quarter ending August 2019[[134]](#footnote-135)
* The mining sector is in the middle of a technological transformation, but there is concern that some of the innovation activities are ‘hidden’ from current measures
* While the number of businesses in the mining sector is small, its economic impact is large. Current business innovation metrics use the business as the unit of analysis without any weighting for size of the business. Therefore, when looking at metrics, such as the percentage of businesses that are innovation active, the contribution of the mining sector to the metric itself is not significant, despite the large overall economic activity of the mining companies supported by their suppliers
* There have been substantial cost reductions in iron ore extraction by large businesses in the sector since 2007,[[135]](#footnote-136) but there may be gaps in reporting these cost savings from new processes, whereas increases in revenue from new goods or services are captured
* Over this same period, Australia’s share of international exports in iron ore and coal has grown substantially, despite Australia’s high salary cost base[[136]](#footnote-137)
* There is interest in better understanding the impacts of innovation occurring in the mining sector, for example, through cost reductions, productivity gains, revenue increases, or otherwise, and the practicalities that may be involved in measuring them.

### Agriculture Sector

**Rationale for selection**

* Australia’s agriculture sector contributed around $47.99 billion of GVA to GDP in 2017–18 at current prices (2.60 percent of GDP).[[137]](#footnote-138) The agriculture sector had revenue of $99.06 billion in 2017–18.[[138]](#footnote-139) The agriculture sector employed about 2390,000 persons full-time and 80,000 part-time as at the quarter ending August 2019[[139]](#footnote-140)
* Australia is a major agricultural producer and exporter. Demand for agricultural products is set to increase in future as the world population grows
* The agriculture, forestry and fishing sector in Australia saw the largest MFP gains and labour productivity in 2016–17, compared to other sectors, despite facing quite challenging environmental conditions[[140]](#footnote-141)
* Australia does measure innovation in agriculture through the ABS BCS. However, the Oslo Manual did not suggest the inclusion of agriculture, forestry and fishing in innovation surveys until the 4th edition (October 2018), so at present, international comparison data is scarce (Norway, Spain, Serbia, the Netherlands, Canada and New Zealand also publish innovation in agriculture data)[[141]](#footnote-142),[[142]](#footnote-143),[[143]](#footnote-144)
* Data from 2016 and 2017 indicates that the proportion of agricultural businesses that are innovation active varies considerably (from 19.5 percent for Spain to 34.7 percent for Australia to 65.4 percent for Norway)
* Current Australian innovation measures show that agriculture is characterised by smaller businesses that are less innovative and larger businesses that are highly innovative. Collectively their contribution is of significance to Australia’s GDP
* The level of BERD in this sector is not consistent across countries. New Zealand’s BERD contribution in agriculture is twice that of Australia; Spain’s is one-third; Denmark’s is one-sixth. Canada did not publish BERD data for the agriculture sector
* Innovation within the agriculture sector takes place within an ecosystem involving many different actors, including: agricultural research institutions, Rural Research & Development Corporations (RRDCs), domestic and multinational companies, and farmers and managers
* Process innovations in the agriculture sector may be driven by product or process innovations by suppliers in other sectors of the economy. Innovation in the agriculture sector is hard to study in isolation.

### Health Services Sector

**Rationale for selection**

* Australia’s health services sector contributed around $127.55 billion of GVA to GDP in 2017–18 at current prices (6.90 percent of GDP).[[144]](#footnote-145) The private sector component of the health services sector had revenue of $139.05 billion in 2017–18.[[145]](#footnote-146) The sector employed about 963,000 persons full-time and 778,000 part-time as at the quarter ending August 2019[[146]](#footnote-147)
* Australia is a large investor in health and medical services, and in   
  2016–17, Australia invested a record high of $180.7 billion on health[[147]](#footnote-148)
* Australia’s health system functions at a relatively low cost (as a percentage of GDP) compared to five key comparator countries – the UK, Canada, US, Germany, and Norway – yet outperforms these same countries on the vast majority of health status indicators
* However, the gap between health expenditure growth and GDP growth in the most recent years showing signs of widening and highlights why it is important for Australia to ensure that its innovation policies in the health services sector are appropriate, and to track innovation outcomes[[148]](#footnote-149)
* Measurement of innovation (inputs and outputs) for the health services sector is lacking because the existing metrics do not capture public sector innovation, and health innovation does not contribute to current innovation metrics
* Health services (and healthcare and social assistance more broadly) is not in scope of the 2018 Oslo Manual.[[149]](#footnote-150) It also falls outside the ABS definition of the market sector (as the services are predominantly provided by governments) and therefore does not contribute to the assessment of Australia’s overall economic performance and MFP. This omission is increasingly problematic given its growing significance.[[150]](#footnote-151)

### Financial and Insurance Services Sector

**Rationale for selection**

* Australia’s finance and insurance services sector contributed around $163.35 billion of GVA to GDP in 2017–18 at current prices (8.84 percent of GDP).[[151]](#footnote-152) The sector employed about 364,000 persons full-time and 78,000 part-time as at the quarter ending August 2019[[152]](#footnote-153)
* By world standards, this sector is sophisticated, competitive and profitable
* Australia’s four major banks are among the world’s largest banks by market capitalisation, and all rank in the global top 25 safest banks list. They are also some of the most profitable in the world
* Australia has the fourth-largest pool of investment fund assets in the world and the largest in Asia[[153]](#footnote-154)
* Australia has one of the world’s best performing financial centres[[154]](#footnote-155)
* The finance and insurance services industry made a significant contribution to BERD (accounting for 19 percent of total BERD in   
  2015–16)
* Fintech is one of the fastest growing sectors in the global financial services industry and is disrupting the financial services industry.[[155]](#footnote-156) Significant R&D activities are occurring in computer software. The accelerating rate of technological change and increasing penetration of mobile devices, combined with shifting customer preferences, have been rapidly changing how financial services are structured, delivered and consumed. For example, in-branch interactions have now largely been replaced by ATMs, online transactions and mobile services. This trend is evident in Australia and in other countries in the Asia-Pacific region. Future innovation in financial technology is expected to lead to further changes, delivering new services and generating new types of employment.

### Methodology

The Review consulted with key representatives from the sectors selected for case studies. To ensure coverage of the sector and consider diversity of perspectives, the Review identified a range of potential stakeholders, including: small, medium and large businesses; peak bodies and industry-owned companies; statutory bodies; and academic institutions.

The consultation process involved interviews that were conducted with individuals or in groups. The minutes of the interviews were cleared by the interviewees. To ensure that interviewees felt able to be entirely frank, the Review gave an assurance that identifiable minutes will not be published. A confidentialised compendium of minutes has been prepared to enable the learnings to be preserved for later use.

In undertaking the interviews, the Review aimed to:

* develop an overview of the sector, including drivers of innovation
* understand how innovation occurs in each sector
* understand how innovation is currently measured in the sector
* identify the measurement implications, including what is not currently being captured and where there may be opportunity to improve current measures.

The Review asked questions related to:

* the organisation, its functions and processes
* R&D activities
* Non-R&D innovation activities
* implementation of innovation
* transfer of knowledge (i.e. sources of innovation and collaborations).

In addition to the interviews, a range of information sources were consulted to provide further context and supplement the evidence provided by interviewees

More information on how the case studies were conducted – and the range of companies interviewed – is provided at the end of this chapter. This also includes the Australian and New Zealand Standard Industrial Classifications (ANZSIC 2006) covered.

Table B.1: Summary of findings

| Finding | Mining | Agriculture | Health Services | Finance and Insurance Services | | Measurement implications |
| --- | --- | --- | --- | --- | --- | --- |
| INNOVATION ACTIVITY OCCURING | | | | | | |
| The IMR found that there is significant innovative activity. | Yes | Yes | Yes | Yes | Significant innovation activity was identified in all sectors.  Small businesses in the health services sector have a lack of incentive to be innovative under the present system. The incentives in place encourage a focus on volume rather than innovation. | |
| Non-R&D innovative activity accounts for a significant fraction of total innovation expenditure. | Yes | Yes | Yes | Yes | Measures of innovation that focus on expenditure on R&D do not offer a complete picture of the innovation activity occurring.  Sectoral study participants reported spending more on non-R&D innovation than on R&D.  A comparison of the non-R&D innovation expenditure reported to the Review with the expenditure reported to the ABS for selected businesses (under ABS return to source arrangements for mining and using businesses’ own records for other sectors) suggests that non-R&D innovation expenditure may be significantly under-reported to the ABS in the BCS.  The key issue is that non-R&D innovation is not an accounting line item and many businesses do not collect the information necessary to calculate it. Some C suite executives were able to provide lower bound estimates by totalling major non-R&D innovations. These were not in the majority. | |
| Innovation activity is concentrated in a small number of large businesses. | Yes | No | Yes | Yes | Metrics that report innovation activities based on the number of innovation active businesses do not adequately measure the contribution to innovation as a small number of large businesses are highly innovative and make a significant contribution to the Australian economy. | |
| Public sector innovative activity is occurring. | No | No | Yes | No | Public sector non-R&D innovation is not currently captured in existing non R&D innovation metrics, being out of scope of the BCS. | |
| There is a significant level of investment in intangible assets (e.g. digital innovation). | Yes | Yes, at a lower level | Yes | Yes | Measurement of investment in intangibles is recognised as a data gap (discussed in Chapter 2). | |
| The scale and range of innovation activities taking place in businesses is diverse. Activities range from disruptive, radical large scale changes that represent a significant departure from business-as-usual through to continuous improvements that are more gradual, incremental changes with limited departure from business-as-usual. | Yes – majority of activity is continuous improvements | Yes | Yes | Yes | The way that innovation occurs in businesses is likely to affect how innovation activity is reported.  Large scale changes are more likely to be recognised by businesses as innovation, and therefore reported in surveys.  Continuous improvements may not be reported, or even be seen, by businesses as innovation. Collectively continuous improvements are likely to have a significant impact. Some businesses, on learning that continuous improvement should be included, indicated they had previously lodged substantial undercounts of non-R&D innovation expenditure. The largest single undercount reported in the sectoral studies was by a business that said including continuous improvement would have raised its non-R&D innovation expenditure by around $100 million. | |
| SOURCES OF INNOVATION | | | | | | |
| R&D is undertaken in-house by staff involved in production (or service) rather than as distinct R&D activity involving R&D personnel. | No | No | Yes | No | When R&D is integrated into ongoing operations, full capture of R&D inputs and outputs might not occur. | |
| Suppliers are a key source of innovation. | Yes | Yes | Yes | No | The scale of this activity is not known as there are no measures in place. | |
| Clients are a key source of innovation. | No | No | No | Yes | The scale of this activity is not known as there are no measures in place. | |
| Significant amount of innovation is sourced from overseas. | Yes | Yes, at a lower level | No | Yes | The scale of this activity is not known as there are no measures in place. | |
| INNOVATION CONCEPTS | | | | | | |
| There are misunderstanding of innovation concepts or differences in terminology within the sectors. | Yes | Yes | Yes | Yes | The Oslo Manual definition used by this review and by the ABS is not in general use in the community. Some businesses have their own definitions of innovation. These are in general narrower (meaning that some activities and expenditures recognised as innovation according to the Oslo Manual are not recognised as such and reported by businesses, leading to undercounts). Sometimes these reflect businesses’ need to report using the Research and Development Tax Incentive (RDTI) program’s definition. Individuals reporting on innovation may report only what they consider to be innovation, as discussed above. | |
| IMPACTS AND BENEFITS | | | | | | |
| Businesses tend to evaluate benefits and impacts of innovations introduced over a longer time period (greater than one year). | Yes | Yes | Yes | No | A single-year reference period is not likely to offer meaningful information on the benefits and impacts of innovation implemented for the sectors examined except for finance and insurance services. | |
| The impacts and benefits of innovation assessed by businesses go beyond economic. | Yes | Yes | Yes | No | Current measures tend to focus on the economic benefits of innovation. | |
| Businesses consider environmental factors when assessing impacts and benefits. | Yes | Yes | No | No | Environmental impacts and benefits of innovation are not currently measured. | |
| Businesses consider safety factors when assessing impacts and benefits. | Yes | Yes | Yes | No | Safety impacts and benefits of innovation are not currently measured. | |
| Businesses consider social factors when assessing impacts and benefits. | No | Yes | Yes | Some | Social impacts and benefits of innovation are not currently measured. | |
| Businesses consider health factors when assessing impacts and benefits. | No | Yes | Yes | No | Health impacts and benefits of innovation are not currently measured. | |
| Businesses have the ability to estimate impacts such as productivity gains and cost reductions. | Yes | No | Yes | Yes | The Review asked whether businesses would be able to provide estimates of the impacts of process innovations, if requested. Sectoral study participants in mining, health services and finance and insurance services believed they could provide estimates of a quality useful to Australian governments. Businesses in agriculture generally did not feel able to provide estimates at all, and those that did thought their estimates may not be within ±20 percent of true values. The Review believes this result occurred as large businesses were better able to estimate the benefits than small businesses. | |
| COLLABORATION | | | | | | |
| Collaboration is occurring on a fee-for-service basis. | Yes | Yes | Some | Yes | Fee-for-service arrangements of a collaborative nature are not currently captured, even if IP and risk are being shared through them. | |
| Capture the full extent of collaborative activities. | No | No | No | No | Current measures of collaboration are aligned with the Oslo Manual and do not include fee for service arrangements, as these are explicitly excluded from the definition of collaboration. | |
| ANALYSING INNOVATION ACTIVITY | | | | | | |
| Ability for businesses to estimate total expenditure on innovative activities (including non-R&D). | Yes | No | No | Yes | Mining and finance and insurance services have some ability to estimate total expenditure, but would provide undercounts based on their current accounting practices. For health services, R&D is being conducted by employees not classified as researchers, so there is significant under-reporting. | |
| Internationally comparable data is available. | Yes | No | No | Yes | Benchmarks are useful to gauge relative performance of Australian industries to the rest of the world.  The government’s ability to collect such data is largely dependent on whether businesses see value in contributing. | |
| Information or data relating to intangibles is being fully captured by businesses. | No | No | No | Yes | More focus is required on measuring intangibles, particularly due to increasing digitalisation.  In principle, there is significant granularity possible in mapping the components of innovation that would be served by better collection of intangibles. | |

## Mining

### Summary of findings

* The scale and range of innovation activities in the mining sector is diverse across and within businesses
* Step-change, or disruptive innovation, is often what comes to mind when thinking about innovation in the mining sector, but the sectoral study found that most innovation activity occurring in the sector can be considered continuous improvement (including in dollar value terms)
* Measures that focus on new processes will be more useful in understanding mining sector innovation than metrics that focus on new products
* The way that innovation occurs impacts on how businesses report their activity through innovation surveys. As a result, there are continuous improvements that theoretically meet the definition of innovation set out by the Oslo manual, but would be ‘hidden’ from current measures
* Estimates of innovation activity that use business as a unit of measurement do not account for the economic contribution that innovation in mining businesses may provide, as the innovation of a small number of large businesses is important in this concentrated sector
* Timing needs to be considered when measuring innovative activity. A single reference year is too short a period to use when assessing impacts and benefits of innovation in the mining sector
* Measuring the outcomes from innovation in mining means going beyond economic results to include safety and environmental factors, and needs to be assessed both qualitatively and quantitatively
* The absence of primary mining suppliers in Australia means that a significant amount of innovation and technological capability is brought in from overseas
* Significant collaboration is occurring in the mining sector, however it is performed on a fee-for-service basis, and current measures may not capture the full extent of activities
* Some large mining industry businesses called for the Government to measure imports by type, and in particular, to measure investment in remote operations technologies. They felt that there may be sufficient domestic demand for a business located in Australia providing remote mining technologies to be commercially viable.

### Summary of opportunities

* Regular case studies should be conducted on the mining sector to improve our understanding and ability to measure the scale of innovation activity occurring. This would complement existing measures and provide an effective source of qualitative information on key issues, such as ‘hidden innovation’, to enable greater evaluation of impact over time
* The ABS should explore opportunities to produce alternative estimates of innovative activity that complement existing methods, and present a more complete picture of the scale of innovation in Australian businesses. For example, if business innovation estimates could be produced in a way that take into account business size (for example, measured by employment size or annual revenue), there would be greater understanding of the relative impacts of innovation in Australian businesses
* Innovation surveys should have a reference period greater than one year to improve the quality of data that is collected on the impacts and benefits of new innovation
* There should be improved analysis of collaborative arrangements that are occurring on a fee-for-service basis.

### Background and context

**The Industry**

Australia leads the world in mineral resources, with the largest reserves of iron ore, gold, lead, nickel, uranium and zinc.[[156]](#footnote-157) Although the mining sector is small with respect to the number of businesses operating in Australia, its economic impact is significant.

As at June 2017, there were 7,800 companies in the mining sector, representing 0.35 percent of total operating businesses in Australia (2,238,000).[[157]](#footnote-158) A small number of very large mining businesses dominate the sector. The mining industry contributes $151.59 billion GVA (8.2 percent GVA as a proportion of GDP) to Australia’s GDP.[[158]](#footnote-159) The mining sector is growing, and is estimated to contribute a record high $252 billion of exports in 2018–19.[[159]](#footnote-160)

Australia has a revealed comparative advantage in mineral products, which accounts for around 54 percent of the value of total exports in 2016, led by iron ore ($48.2 billion), coal briquettes ($47 billion), gold ($29.1 billion) and petroleum gas ($20.3 billion).[[160]](#footnote-161),[[161]](#footnote-162) However, Australia’s comparative advantage in the mining sector is not purely the by-product of its rich mineral reserve. While global demand for minerals has continued to grow strongly over the last 20 years,[[162]](#footnote-163) Australian mining businesses have faced a number of recent challenges, including:

* fiercely competitive international commodities markets
* declining quality or less accessible recoverable mineral deposits in Australia
* the highest industry wages (full-time ordinary time earnings of over $138,000 per year) driven by a shortage of skilled domestic workers.[[163]](#footnote-164)
* the health and safety of employees has become a high priority for mining companies
* the environmental impacts of mining operations are a key concern for mining companies
* the absence of primary mining suppliers in Australia means that a significant amount of this capability is brought in from overseas.

**Innovation**

Conditions have presented businesses with a significant productivity challenge, with the industry experiencing falling MFP in the   
12 year period between 2000–01 and 2012–13 (Figure B.1).[[164]](#footnote-165) Responding to this challenge, the mining industry has undergone a period of rapid change over the last 10 years to keep the cost of production to a minimum and remain globally competitive. To do this, businesses within Australia’s mining sector have invested in innovation activities, such as the implementation of new technology, R&D, continuous improvement processes and collaboration with suppliers and other partners.

The industry has been recording growth in MFP and labour productivity since 2013–14, which is indicative of the significant innovation activities that have been occurring in mining businesses over recent years. However, questions have been raised about the extent to which innovation metrics and data sources have been effectively capturing and measuring these activities and their impacts.

Figure B.1: Multifactor Productivity, Mining and selected industries, 1989–90 to 2016–17

| Figure B.1 (page B16) is a graph of the gross value added multifactor productivity indexes for the four sectors: agriculture, forestry and fishing, mining, manufacturing and information, media and telecommunications for the time period (x axis) of 1989-90 to 2016-17. The index is set at 100 in the 2015-16 financial year. The graph shows that multifactor productivity in the mining sector has decreased from its peak in the 2000-01 financial year. There has been a slight increase in multifactor productivity from a low in the 2012-13 financial year. |
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Source: ABS Cat. No. 5260.0.55.002 – Estimates of Multifactor Productivity, Australia, 2016–17

Scorecard metrics have used measures of expenditure on R&D as a proxy for innovative activity. As shown in Table B.2, in 2015–16, business R&D expenditure varies based on the relative size of businesses in the sector.[[165]](#footnote-166) In comparison to the broader R&D landscape in Australia, in mining, larger companies (with 200 or more employees) account for more of the R&D conducted. Although the contribution of business R&D in the mining sector amounting to over $1.8 billion might seem impressive, it is less than one percent of the total revenue generated by the mining industry. Moreover, this figure has decreased since 2013–14. It is clear that R&D expenditure alone does not provide the full extent of innovation activities occurring in the mining sector.

While expenditure on R&D has decreased, the mining industry has experienced growth in MFP over the last five years.[[166]](#footnote-167) This growth has come after falls since 2000. The mining investment boom, created by higher commodity prices, required substantial inputs of capital and labour ahead of production. In addition, less productive techniques that were able to be implemented more quickly were preferenced over more innovative methods with longer lead times.[[167]](#footnote-168) Since the mining boom, the industry has been in the midst of a technology-enabled transformation that may be contributing to productivity growth.[[168]](#footnote-169) As discussed earlier at Chapter 6 – Analysis, there are implications that sources of innovation contributing to MFP change are hidden from current metrics.

Table B.2: Expenditure on R&D by size of business in the mining sector

|  | **Mining** | **Overall** |
| --- | --- | --- |
| 0–4 people (micro) | 8.4% ($158 million) | 6.4% ($1062 million) |
| 5–19 (small) | 10.6% ($198 million) | 12.3% ($2054 million) |
| 20–199 (medium) | 10.6% ($198 million) | 24.1% ($4008 million) |
| 200+ (large) | 70.4% ($1322 million) | 57.2% ($9535 million) |
| total | 100% ($1876 million) | 100% ($16,659 million) |

Source: ABS Cat. No. 8104.0 – Research and Experimental Development, Businesses, Australia, 2015–16

### How innovation occurs in the mining sector

This section outlines how innovation occurs in the mining sector and highlights some of the measurement implications arising from these activities.

**The focus is on process innovation**

When it comes to innovation, the focus of businesses in the mining sector is on developing, introducing or improving processes to deliver a minimum viable product, rather than the development of new goods or services. This is not surprising given that the products these businesses sell (for example gold, coal, iron-ore) are, with the exception of purity and configuration, identical to what humans first mined at the dawn of civilisation. They are commodities that are typically used as inputs in the production of other goods and services. There would be little need or conceivable opportunity for new products to be developed by mining businesses.

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| **Measurement implications**   * Process innovation is conceptually within the scope of business innovation surveys (i.e. the ABS’ BCS), although in practice there is significant undercounting (hidden innovation). * Measures that focus on new processes will be more useful in understanding mining sector innovation than metrics that focus on new products. |

**Process improvements drive innovation**

The drivers of innovation in the sector reflect this focus on process innovation. The following broad drivers were common across participating businesses:

* Delivery of minimum viable product at the lowest cost.
* Improve the quality of products.
* Improve productivity.
* Improve safety.
* Improve logistics and supply chain capacity.
* Reduce environmental impacts.
* Enhance existing systems.

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| **Measurement implications**   * Drivers of innovation in the mining sector are not purely economic * When measuring the benefits and impacts of innovation, safety and environmental outcomes should be a consideration. |

**The types of innovation vary from continuous improvement to disruptive change**

The key types of innovation in the mining sector sit at opposite ends of the scale of novelty and significance. These are described in Table B.3 below.

Table B.3: Summary characteristics of types of innovation performed in mining businesses

|  | ‘Disruptive’ or step-change innovation | Continuous improvement processes |
| --- | --- | --- |
| *Scale* | Radical, large-scale changes | Gradual improvements |
| *Implementation* | Implemented over a number of stages  From proof-of-concept to full-scale roll-out  Can be abandoned | Incremental changes over time |
| *Timing* | Long-term | Medium-term |
| *Cost* | High capital investment | Modest development costs |
| *Risk* | High – the outcome is often uncertain | Moderate to medium |
| *Technology level required* | Significant technological advances | Some technological advances |
| *Impact on BaU* | Significant departure from business as usual | Limited changes to business as usual |
| *Types of operation* | Common in Greenfield or new mine site operations where there is ability to leapfrog to new technology and processes | Common in Brownfield or more established mining operations |
| *Drivers and benefits* | * Finding solutions to complex problems * Enhanced employee health and safety * Improved environmental outcomes. | * Optimising already evolved processes * Delivery of minimum viable product at the lowest cost * Enhanced employee health and safety * Improved environmental outcomes. |
| *Example* | * Automated subsystems and processes * Automated mining * Fatigue monitoring (SmartCaps) * 3D mapping technologies * Diffraction technology. | * One mining company spoke of a relatively minor, but important, improvement in the quality of knuckles used in train carts to increase durability. Increasing the life span of the knuckles could result in significant cost savings for the business * Adoption of in-field mobile devices to provide frontline personal access to critical information and systems, such as equipment status, hazard reports, and maintenance work orders. |

Although mining companies engage in the development and introduction of innovation at both ends of the scale, participating representatives indicated that the latter is more common than the former. One mining executive estimated that 80 percent of innovative activities in the company could be considered incremental change or continuous improvement, with the remaining 20 percent considered to be disruptive or radical.

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| **Measurement implications**   * Step-change, or disruptive innovation, is often what comes to mind when thinking about innovation in the mining sector, but the sectoral study found the majority of innovation activity falls into the category of continuous improvement * Step-change, or disruptive innovations, are more likely to be reported by businesses when considering ‘new or significantly improved goods, services, processes, or methods’ * Continuous improvements, on the other hand, may involve a large number of small changes that, when taken in isolation, would not be considered ‘significant improvement’ from existing processes, but collectively would have substantial impact * While these continuous improvements theoretically meet the definition of innovation set out by the Oslo manual, the way in which this innovation activity occurs (e.g. incrementally, over long time periods, with limited changes to business as usual) may impact on whether this activity is reported in practice. This may be a source of hidden innovation in the mining sector. |

Research and development is important, but is not the whole picture

As discussed earlier, expenditure on R&D in the mining sector is less than one percent of total revenue generated by the sector (based on 2015–16 estimates). All of the businesses consulted by the Review indicated that, while R&D is important, more innovation activity occurred outside of the R&D space than within it.

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| **Measurement implications**   * R&D activity is well captured through measures of R&D expenditure * Non-R&D innovation activity is recognised as a gap in current metrics. |

**Patenting helps to show how and where innovation is happening**

Patenting is used by mining businesses, but as with R&D, measures of IP use do not provide the full picture of the innovative activity taking place.

However, IP applications provide interesting insights into the location of inventors holding mining patents. The bulk of patents in the mining sector in Australia are filed by Mining Equipment, Technology and Services (METS) businesses that are primarily staffed by inventors located outside of Australia.[[169]](#footnote-170) This aligns with the findings described below.

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| **Measurement implications**   * IP and patenting activity is sufficiently captured through measurement of IP applications * While these measures are not a good proxy for overall innovation activity in the sector, they help build the picture of how innovation is occurring (e.g. through collaboration). |

**Most innovation is implemented incrementally, over an extended period of time**

While some innovations may have clear implementation dates and timeframes (e.g. the introduction of a new durable knuckle used in train carts), the majority occur over an extended period of time, or in phases. For example, Fortescue has spent years expanding its autonomous haul fleet.[[170]](#footnote-171) The technology behind these autonomous vehicles was first introduced in 2013 but it wasn’t until 2018 that Fortescue fitted its first truck with this technology. The long-term goal is to move towards a fully autonomous fleet of about 100 vehicles, which will be the first of its kind in the world. This change will occur over an extended period of time and will require simultaneous workforce skill development that Fortescue describes as the “implementation of a staged, sustainable, redeployment process”.

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| **Measurement implications**   * A single reference year period is considered too short a period to use when assessing impacts and benefits of innovation, which may take longer to manifest in mining * It may not always be clear at what point in time an innovation is considered to be implemented. It is possible that these innovations are being overlooked because it takes more than a year for them to come into play. This may also impact on the way that innovation is reported. |

**Innovation quickly becomes business as usual**

Technology advances and innovation that once would have been considered significant quickly becomes common practice as it is rolled out across the business. For example, drones and robots are used frequently across mining operations to complete maintenance inspections. Drones are used to inspect the mechanical integrity of confined spaces, and robots are used to complete pipe inspections. Once considered ‘disruptive innovation’, these activities are now scheduled as routine maintenance.

Similarly, incremental, continuous changes are so common in the mining sector they are also considered routine or business as usual.

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| **Measurement implications**   * At what point in the implementation process would an innovation no longer be considered by the business as ‘innovative’? * Incremental changes that are considered business as usual may not be recognised and reported as innovation. This may be a source of hidden innovation. |

**Mining businesses and their role in the innovation ecosystem**

Mining businesses are large consumers of the technology-intensive goods and services required to support innovation. Considerable adaptation and implementation activity is undertaken in-house for point solutions and continuous improvement. Businesses work closely with suppliers to deliver solutions to identified problems. A significant proportion of innovation comes from new products and services developed by, or in conjunction with, mining suppliers.

For the large businesses interviewed, predominant partnerships are with primary mining suppliers. Businesses identified the following benefits from these partnerships:

* existing suppliers are lower risk
* they understand the mining environment through their exposure in traditional supply
* they have existing market channels through which they can commercialise solutions.

The absence of primary mining suppliers in Australia means that a significant amount of this capability is brought in from overseas. The scale and extent of overseas expenditure associated with innovation adoption is not known.

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| **Measurement implications**   * It would be useful to improve our understanding on the extent of the expenditure associated with adoption of innovation that is expended overseas, and on what * The scale of this activity is not known, making it hard to determine whether policy intervention is required. |

**Mining businesses are active collaborators**

Collaboration is seen as a fundamental enabler of innovation, as it allows the diffusion of knowledge and sharing of risk and capabilities. Mining businesses are active collaborators.

As discussed above, mining businesses collaborate heavily with their suppliers to innovate and deliver solutions to complex problems, which results in mutual benefits for both parties. For example, one mining company worked closely with a truck supplier to optimise payload limits, enabling improved loading outcomes for the mining business and assisting the supplier to maximise delivery loads closer to approved limits.

Of the mining businesses that participated in the sectoral study, collaborations were also noted with universities, external partners, suppliers, research agencies and METS businesses. These arrangements typically occurred on a fee-for-service basis but were part of long-term relationships in which IP and risks are shared. These fee-for-service arrangements are not captured under the current definition for collaboration in the Oslo Manual. For example, in 2018, Fortescue announced a $20 million agreement in collaboration with CSIRO and Brisbane research laboratories to develop and commercialise hydrogen technologies in Australia.[[171]](#footnote-172)

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| **Measurement implications**   * Since many collaborations occur on a fee-for-service basis, current measures may not capture the full extent of these activities in the mining sector. |

**How the impacts or benefits of innovation are measured varies across businesses**

There is variety in the approaches used by different mining businesses to measure impacts and benefits of implemented innovation.

The general consensus is that innovation requiring a large capital spend will be well tracked to monitor improvements and outcomes that result from implementation. For smaller scale, less resource-intensive innovation, it is less likely that attempts will be made to quantify or measure impacts. For activities that fall into the continuous improvement space, benefits would be difficult to aggregate and quantify at the business level. For some businesses, the benefits are clear without needing to be measured.

There are attempts being made by some businesses to consolidate and capture innovation expenditure and activity across the business to improve tracking and offer transparency to shareholders. For example, some mining businesses are moving towards the coordination of their innovation initiatives by a central portfolio. This centralisation will provide better visibility of all local innovation occurring in the company. In contrast, other businesses see the inherent difficulty in doing this and acknowledge there would be activities occurring that would not be tracked well or have quantifiable impacts.

In summary, benefits can be qualitative as well as quantitative. For example, some innovation may be measured by increased output, whereas other innovation has less quantifiable impacts such as improved safety, reduced environmental impact, and greater social benefit.

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| **Measurement implications**   * Some innovation impacts are easily quantified at the business level and may be measured by increased output of an introduced process * Not all innovations that occur have obvious, quantifiable impacts. Some benefits are qualitative (e.g. social, environmental and safety) * Sometimes the impacts are reduced costs or the removal of something inefficient, instead of introducing something novel. This is harder to estimate (e.g. process innovations, cost reductions or productivity gains that may be embodied in new technology and processes, such as automation) * Impacts may be seen and measured at the macro or whole of industry level, but more detail is desirable. However, since the businesses themselves are not able to quantify the full impacts, this would be very difficult to achieve (i.e. measuring the specific outcomes of minor continuous innovation is challenging) * Although it might be easy to observe each individual change or improvement, it is hard to aggregate all of the innovation that is occurring and assess the cumulative impact of these small projects. |

**A strong culture of innovation is important for driving organisational capability**

The companies interviewed for the case studies highlighted the importance of encouraging and fostering a culture of innovation. Management plays a key role in empowering staff to feel confident in generating new ideas, and a number of initiatives have been implemented to capitalise on the diverse skill sets of staff across different areas of the business. For example, one business promotes a ‘shark tank’ style initiative, where staff have the opportunity to present innovative ideas for the consideration of an expert panel.

Training is seen as a key enabler, and businesses actively support the professional development of staff. One business offers training to develop capability in writing a business case. This ensures that staff have the appropriate skills and tools to feel confident in proposing innovative ideas to improve the business, as well as feeling they have the support of management. These businesses also consider that failure, as well as success, should be embraced as a valuable learning experience. The establishment of positions, such as Head of Innovation, also helps to promote and acknowledge the ongoing importance of innovation within the organisation.

Throughout the interviews, it was apparent that a broad range of activities are working together to develop an innovation culture within these businesses. It is difficult to identify the specific impact of any one factor in driving innovation.

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| **Measurement implications**   * Innovation capabilities are difficult to measure, due to their intangible nature. |

## Agriculture

### Summary of findings

* The agriculture sector is heavily intertwined with other sectors. Relative to other sectors, agriculture has a high proportion of small businesses. Based on the conversations held during this Review, the agriculture sector appears to be predominantly an adopter of innovations developed in other sectors, but businesses in the agriculture sector collaborate with these innovators to optimise adoption for local conditions
* The ability of policymakers to implement informed decisions in the agriculture sector has previously been restricted by the lack of data, but there are opportunities to improve the reliability and availability of data (for example, through increased digitalisation)
* The agriculture sector is a good example of where key concepts of innovation may not be adequately understood and captured in the data
* There are significant levels of collaboration in agriculture across all areas.
* There is appetite in the sector for the review of social, health and environmental impacts that are not typically quantified in innovation measurement
* Innovative activities in the agriculture sector also vary with respect to their timeframe for implementation
* There is significant investment in non-R&D and business improvement activities that have the potential to be missed in the assessment of agricultural innovation
* In the digital space, there are new ways of generating knowledge that do not rely on R&D processes, such as hypothesis testing
* There is a lack of internationally comparable data.

### Summary of opportunities

* Surveys should have a reference period greater than one year to improve the quality of data that is collected on the impacts and benefits of innovation in the agriculture sector
* Misunderstandings regarding the concepts of innovation could be addressed by including sector-specific explanations and examples in survey instruments
* Measurement of social, health and environmental benefits of innovation that are not typically quantified in innovation measurement should be considered
* There should be collection of data on, and analysis of, collaborative arrangements that are occurring on a fee-for-service basis.

### Background and context

**The Industry**

For the purpose of this sectoral study, businesses from the farming, forestry and aquaculture industries are collectively addressed as the agriculture sector.

Australian farmers are the custodians for over half of Australia’s land area.[[172]](#footnote-173) The agriculture sector is comprised of a significant number of companies. In 2016–17, there were 177,251 companies, representing over eight percent of total businesses in Australia.[[173]](#footnote-174) However, the majority of these (~99 percent) are either non-employing (125,160 businesses) or micro agriculture companies (49,891 businesses) employing fewer than five staff. At the end of 2016, there were only 80 large businesses operating in the agriculture sector.

Australia’s agriculture sector contributed around $47.99 billion of GVA to GDP in 2017–18 at current prices (2.60 percent of GDP). The agriculture sector, therefore, makes a large contribution to the Australian economy through many small companies. This is in contrast to the mining industry, where large contributions are made by a small number of major businesses.

In addition, business operation in the Australian agriculture sector is the most prone to fluctuations from external forces, such as the costs of inputs and environmental factors.[[174]](#footnote-175) The sector is also one of the least likely to collaborate, with just six percent of businesses reporting they have collaborative arrangements in place.

**Innovation**

Innovation in the agriculture sector is especially important for business success. In 2016–17, 48.8 percent of innovation-active agricultural businesses reported increased revenue from the previous year, compared to the Australian average of 42.3 percent.[[175]](#footnote-176) Innovation in agriculture is primarily sourced from suppliers and customers, especially when it comes to large businesses.[[176]](#footnote-177) These suppliers and customers may be from outside the agriculture sector, for example, in manufacturing, wholesale and retail trade. In comparison, innovation in the mining sector is mostly sourced in-house.

The agricultural industry has experienced a period of rapid change over the last 10 years to keep the cost of production to a minimum and remain globally competitive. The agriculture industry in Australia had the largest MFP gains and labour productivity gains compared to other industries between 2000–01 and 2012–13 (See Figure B.2).[[177]](#footnote-178)

Figure B.2: Multifactor Productivity, Mining and selected industries, 1989–90 to 2016–17

| Figure B.2 (page B27) is a graph of the gross value added multifactor productivity indexes for: agriculture, forestry and fishing; mining; manufacturing; and information, media and telecommunications for the time period (x axis) of 1989-90 to 2016-17. The index is set at 100 in the 2015-16 financial year. The graph shows that multifactor productivity in the agriculture, forestry and fishing sector has shown steady increases in multifactor productivity from the first measurement point on the graph in the 1989-90 financial year. |
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Source: ABS Cat. No. 5260.0.55.002 – Estimates of Multifactor Productivity, Australia, 2016–17

However, questions have been raised on the extent to which innovation metrics and data sources have been capturing and measuring these activities and their impacts.

The continued funding of R&D activities is essential for improving agricultural productivity and profitability.[[178]](#footnote-179) In 2014–15, over $3 billion in R&D funding was allocated to rural activities. Of this amount, $1.46 billion was sourced from industry, $0.95 billion from the Australian Government, $0.24 billion from state Governments and $0.35 billion from universities.

Business R&D expenditure varies based on the relative size of businesses in the sector.[[179]](#footnote-180) In comparison to the broader R&D landscape in Australia, R&D is performed less by larger companies (with 200 or more employees) and more by medium-sized companies (20–199 employees) (Table B.4).

Table B.4: Expenditure on R&D by size of business in the agriculture sector

|  | **Agriculture** | **Overall** |
| --- | --- | --- |
| 0–4 people (micro) | 11.3% ($28 million) | 6.4% ($1062 million) |
| 5–19 (small) | 10.1% ($25 million) | 12.3% ($2054 million) |
| 20–199 (medium) | 41.1% ($102 million) | 24.1% ($4008 million) |
| 200+ (large) | 37.5% ($93 million) | 57.2% ($9535 million) |
| total | 100% ($248 million) | 100% ($16,659 million) |

Source: ABS Cat. No. 8104.0 – Research and Experimental Development, Businesses, Australia, 2015–16

The Research and Development Tax Incentive (RDTI) is an initiative by the Australian Government to encourage companies to engage in R&D.[[180]](#footnote-181) The initiative provides a tax offset to Australian companies to claim the cost of eligible activities. In 2017, the agriculture sector reported $466 million in expenditure under the RDTI, which was 3.3 percent of the R&D expenditure reported under the RDTI.

The majority of this research (85 percent) was in the agriculture and veterinary sciences area. This indicates most R&D is performed in crop and animal farming, fisheries, horticulture and farm management. Less than two percent of R&D was conducted in the information management and digital technology research areas. From this breakdown, it appears that the majority of agricultural businesses concentrate their efforts on research specific to their own sectors. They are not investing in R&D that may have spillover benefits for other sectors. For example, businesses in these sectors are not innovating in new technology, such as autonomous vehicles or digital infrastructure, and are most likely getting these innovations from elsewhere via procurement activities.

### How innovation occurs in the agriculture sector

This section outlines how innovation occurs in the agriculture sector and highlights some of the measurement implications arising from these activities.

**Lack of data has impacted on the ability to respond effectively to challenges**

Australia faces unprecedented challenges in the agriculture sector. This uncertainty led the Department of Agriculture to conduct a comprehensive consultation process with stakeholders across the agricultural innovation system in 2019. It found that the sector is becoming increasingly digitalised, however, existing data is highly disaggregated, siloed and inconsistent.[[181]](#footnote-182) To improve on a shared vision for the future, Department of Agriculture recommended that components of the agricultural ecosystem, such as leadership, investment, governance, funding, and culture, needed to adapt.

In 2015, the ABS and the Australian Bureau of Agricultural and Resource Economics Sciences (ABARES) undertook the National Agricultural Statistics Review (NASR) to assess the adequacy of agricultural statistics systems in Australia. The review found a number of deficiencies and concerns, and recommended actions to deliver a modern statistical system based on best practice principles. The NASR indicated that there should be a shift away from surveys to data collected during the course of normal business operations. The NASR also suggested that emerging sources, such as Big Data, satellite imagery and machine learning, be explored for potential use in the statistics system (The statistical applications of satellite imagery are currently being explored).

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| **Measurement implications**   * The ability of policymakers to implement informed decisions in the agriculture sector has been restricted by the lack of data, but there are opportunities to improve reliability and availability of data (for example, through increased digitalisation). |

**Social, health and environmental benefits need to be measured**

The measurement of innovation has previously focused on economic indicators. However, the agriculture sector’s contribution extends to social and environmental wellbeing. These benefits contribute to:

* future demand (e.g. increasing population and personal incomes)
* current and future environmental conditions (e.g. weather, climate, pests, drought)
* competition for natural resources (e.g. land, water)
* technological opportunities and digital disruption
* customer expectations (e.g. trends, diets, demand for healthier food).

As highlighted in Department of Agriculture’s consultations, the agricultural industry is also the sector that will be most affected by environmental and social challenges, such as global food production shortages and climate change.[[182]](#footnote-183) This view was shared by sectoral study participants, who described the challenges of implementing innovation due to environmental factors beyond their control. In addition, the supply chain has broader impacts on health, the environment and social benefits. Department of Agriculture highlighted a bias towards return on investment at institutional levels, and recommended the industry should focus more on social and environmental outcomes to reflect its true value to the economy.

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| **Measurement implications**   * Innovation is key to productivity, which leads to improved living standards. Environmental and social impacts are also critical to living standards and therefore need to be measured effectively to improve our understanding of the impacts of innovation. While these are outside the scope of this Review, they are highly significant for agriculture, and could usefully be the subject of further work. |

**Non-R&D investment and business improvement need to be effectively measured**

There is significant investment in non-R&D and business improvement in the agriculture sector, partly as a result of innovation in related sectors, such as manufacturing; and professional, scientific and technical services.

One company estimated the post-launch expenditure on a product intended for use in agriculture is typically 50 percent of the cost of its initial development. For example, if $100 million is invested in the development of crop protection products over a period of five years, there is a further investment of around $50 million over the next five years on post-launch activities. These include extension activities, for example, generating data on the use of products in different environmental conditions, and field trials for regulatory registration requirements.

Nufarm’s development and production of omega-3 canola through its subsidiary Nuseed is an example of innovation that feeds into the agriculture sector. The development of this technology has been widely recognised as a world-first, and this is Australia’s first wholly created genetically modified crop.[[183]](#footnote-184)

There are other forms of innovation that are also considered important for the success of the business. Previously, Nufarm provided seeds and crop protection solutions to farmers, who then sold their grain to an established market industry. However, the production of long-chain omega-3 fatty acids opened up a new market in the aquaculture industry that required a different business model for the company. Through their subsidiary Nuseed, Nufarm is inventing the seed and maintaining ownership of the grain. It is now involved in all parts of the production process leading to the sale of the final product, something that has never been done before. The implementation of this new model would be classed as innovation as it requires changes to the overall approach of the business.

**There is considerable extension of non-R&D agricultural products in the sector**

Companies interviewed by the Review indicated that a major focus has been on extension activities. However, they feel there is a gap in the collection of this data. In the past, agriculture and primary industry departments allocated larger amounts of funds for these activities. The criteria have since changed and extension activities are now either rolled up into R&D projects[[184]](#footnote-185) or progressed by the private sector. As a consequence, agricultural non-R&D innovation data are not adequately collected. Concerns were also raised about the effectiveness of knowledge transfer to feed into metrics of adoption time periods.

Elders undertakes non-R&D innovation and extension to test products that come to market, using a hands-off outsourced model. For example, Elders has partnered with multinational chemical businesses on a fee-for-service basis to undertake trials in Australia on biological products and adjuvants for broad acre crops. Elders’ role is to co-ordinate the extension phase of the process. Elders arranges trial sites and expertise (labour) to test products on behalf of the multinational chemical businesses. These products are generally in trials for a period in excess of three years. This provides information on the suitability of new chemicals against current products to support high quality broad acre commodity production. However, the innovation is reported only by the multinational and would not be captured in Australian innovation statistics.

This example highlights the complexity, both of measuring innovation and correctly allocating it.

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| **Measurement implications**   * Core R&D by multinational agrochemical companies in the manufacturing sector impacts on business process improvement in the agriculture sector * The intertwining of sectors is an issue that should be considered in the next ANZSIC review. It is very difficult to consider agriculture in a meaningful way on its own * The sectoral study found a large proportion of activity occurring in the agriculture sector relates to non-R&D innovation (such as extension activities) and business improvements that are either new-to-business or new-to-sector and have substantial impacts on the economy * While these continuous improvements meet the definition of innovation set out by the Oslo Manual, there are gaps in the way these activities are recorded that may impact on the quality of data. |

**A large proportion of core R&D activity is performed overseas**

RRDCs are the main way in which the Australian Government and primary producers co-invest in R&D for industry and community benefit. In 2014–15, it was estimated that RRDCs had oversight of $483 million. Of this amount, $277 million was funded by private sector levy payments.[[185]](#footnote-186) All RRDCs consulted with funded research projects through R&D facilities, such as CSIRO. RRDC guidelines are followed for impact assessment, including adoption phases. These processes evaluate the potential for benefits to the industry over an investment period of up to 25 years.

However, in the seed and crop protection areas, businesses are less likely to perform this R&D in Australia. Agricultural businesses interviewed for the sectoral study indicated that multinational organisations are key drivers in the R&D of chemical-based advancements. Where they are not developed and released into Australia through these companies, local businesses adapt the formula of these chemicals for domestic conditions.

There is an absence of seed and crop protection companies that perform R&D activities in Australia. This means that businesses are likely to bring in innovation and capability from overseas for adaption to Australian conditions. Innovation is likely to occur in extension, rather than R&D.

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| **Measurement implications**   * This further emphasizes the importance of capturing innovation considered as ‘extension’. |

**Key concepts for innovation may not be fully understood by the sector**

‘Hidden innovation’ refers to activity that is not captured by existing innovation indicators, such as expenditure on research and experimental development, patent applications, or through innovation surveys. The sectoral study interviews identified that some participants in the agriculture sector frame their activities in terms of the need to remain profitable, rather than as new. After a discussion of innovation, a number of participants indicated they had under-reported continuous improvement of business processes.

The majority of businesses (>99 percent) in the agriculture sector are small enterprises with fewer than five employees. A common theme amongst all interviewees in the sector was the message that the strict concepts of innovation are not sufficiently understood by these small businesses. Many farmers do not consider their activities as being new. They also do not see their interactions with others as collaboration, and view them in terms of sharing resources.

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| **Measurement implications**   * Misunderstanding of the concepts of innovation and collaboration for innovation in the agriculture sector may lead to underreporting of innovative activities in surveys. |

**The sectoral study found significant levels of collaboration in agriculture across all areas**

It is not clear if collaborative efforts in the agriculture sector may be underreported between suppliers and farmers. Results from the BCS collected by the ABS indicate that 94 percent of businesses in the agriculture sector do not have collaborative arrangements in place. This makes the sector one of the most underrepresented in this type of metric. The sectoral study found significant levels of collaboration in the sector. However, it oversampled large businesses, and these would be expected to be more likely to collaborate than small businesses.

In particular, there is evidence of significant levels of fee-for-service activity that is collaborative in nature (in that IP and risk are shared) in the agriculture sector and not currently in the scope of the BCS (as fee-for-service activity is excluded from collaboration under the Oslo Manual definition). Agricultural businesses interviewed for the sectoral study reported that they undertake significant collaborative activities through contracts. One respondent indicated that the R&D is not reported in Australia, as it is conducted by multinationals overseas.

Farmers are also considered a key source of innovation for those supplying the sector. One supplier indicated that the closer it was to growers, the better it understood market needs that enabled it to make more effective products. However, it acknowledged that while contact was important, it was difficult to measure and was an easy target for cost-cutting measures.

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| **Measurement implications**   * There is evidence that key concepts of collaboration are not fully appreciated in the agriculture sector. Many relationships are informal, and agreements are verbal and not reflected in contracts at any stage (for example, you test your new product on my land, and if it works and you commercialise your product in future years, you will sell your product to me at a significant discount in future). As a result, current measures of collaboration may not capture the full extent of activities. * There is a significant level of fee-for-service activity – that is collaborative in nature in all sectors – that is not being captured under the current definition of collaboration. |

**The time it takes to measure the impact of innovation can vary**

The agricultural industry, like many other sectors, is increasingly being influenced by digital technology. This can have a significant impact on the time it takes to implement innovation.

Agricultural businesses with tangible product innovations have much longer lead times for development. Some of the main aspects of their work are not implemented until five to eight years after discovery. The BCS collects innovation data for the previous 12 months. As a result, there are potential implications for international comparability in the measurement of innovation. Having a longer reference period is more appropriate for the agriculture sector, based on the long lead times for innovation.

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| **Measurement implications**   * A single reference year period is too short to assess impact in the agriculture sector, as many innovations are not fully implemented within this period. |

**Digital technology may impact the measurement of innovation**

The Yield is a leading start-up in the agricultural technology sector. Working with some the largest corporate growers in the world, it uses its patented technology to produce microclimate weather predictions, even inside tunnels and under netting which powers its apps.[[186]](#footnote-187) The Yield measures 14 variables in real-time that underpin agriculture models to allow growers to know when it is best to plant, irrigate, feed, protect, and harvest. At the corporate level, this information is combined with customer data to solve supply chain problems, such as optimising pricing contracts, inputs, freight, and logistics. It is a leader in data analytics, including machine intelligence and AI.

One of its innovations is its microclimate sensing system, which allows the business installs and supports for customers. It takes care of all support and maintenance, including over-the-air updates in software It remotely monitors performance, including detecting outliers in its sensor fleet, so it can perform maintenance where required.

The Yield is representative of digital technology companies that have applied innovative principles in the agriculture sector. It is considered that current innovation measurement is directed towards tangible outputs (such as the manufacturing sector) and does not adequately capture intangibles, such as digital-based innovation. The Yield platform product allows for the purchase of separate modules, for incorporation into the final products. The company constantly updates and extends these modules which should be considered as innovation, but are not consistently captured in current innovation metrics.

Through its R&D arm, the Thomas Elder Institute, Elders is partnering with various public and private organisations to bridge the gap between research, practical application, and productivity improvements.[[187]](#footnote-188)

One of Elders’ most significant recent innovations has been the development and launch of the Smart Farmer application.[[188]](#footnote-189) Elders identified an opportunity to develop a platform application that incorporates multiple service applications into one dashboard. It works with local agriculture technology companies to collect the data in the Smart Farmer application, then provides customers with a range of information to access through the dashboard.

Accompanying the release of this application is a business innovation in the form of flat fee-for-service consulting that is potentially new to the sector. Previously, agribusiness consultants and agronomists are paid through commissions if a customer makes purchases. With the support of this new technology, Elders’ customers and consultants have better access to information, and this increased productivity allows Elders’ consultants to provide advice more easily when customers need it.

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| **Measurement implications**   * There may be alternate transactional data sources, supported by the adoption of technology on farms, which may provide insights that cannot be gained through surveys. |

## Health Services

### Summary of findings

* The health services ecosystem is complex and involves a variety of actors, in both public and private sector organisations
* The public sector accounts for the majority of health expenditure, however, public sector innovation is not captured through ABS surveys
* Innovation in the sector is difficult to measure, both conceptually and statistically, in a way that is useful for government policy and program development
* The timeframe for implementation of innovation is highly variable, and it can take several years before impact can be measured
* Much of the sector is limited to internal sources of innovation, with overseas and domestic competitors rarely considered a source of new ideas
* Engagement metrics, in combination with clinical indicators, are used as proxies for economic outcomes. Inconsistencies in data are problematic for measurement, and there are no benchmarks for gauging the relative performance of health-care providers nationally
* Core R&D is almost always performed in-house, and in many organisations is integrated into ongoing operations, which makes it difficult to capture R&D inputs and outputs fully
* Other types of R&D commonly result in process innovations, including modifications and incremental changes. The impacts and outputs of these innovations are hard to measure
* Non-R&D innovation includes design, marketing and training activities, and accounts for a significant percentage of investment that may not be captured
* Fee-for-service arrangements are used if specialist skills and knowledge are not available within an organisation (e.g. digital health infrastructure)
* The sharing of knowledge is limited, and innovation-relevant data (if collected) is mostly used for internal purposes. This minimises the potential impact across the sector. National data on innovation activity in the sector is lacking
* There are a few exceptional organisations leading innovation in the sector, but the majority are not considered active innovators. The measurement of health-care output, based on volume rather than quality, may act as a disincentive for businesses in the sector to be innovative.

### Summary of opportunities

* Innovation in government health services should be measured, as should innovation in government services more generally
* Measurement across the entire sector would enable development of metrics to inform investment in health service innovations, which would be valuable for government policy makers
* Fee-for-service arrangements should be included in measurement of innovation expenditure
* Investment in design, marketing and training represents a major opportunity for innovation measurement that should be pursued
* The government should consider incentivising organisations to keep precise and comprehensive records on their innovation activities and improve current reporting arrangements
* Australia should make better use of existing data through data integration (bringing together data from all states and territories) to monitor the quality of its healthcare system and enable international comparison with other OECD countries.

### Background and context

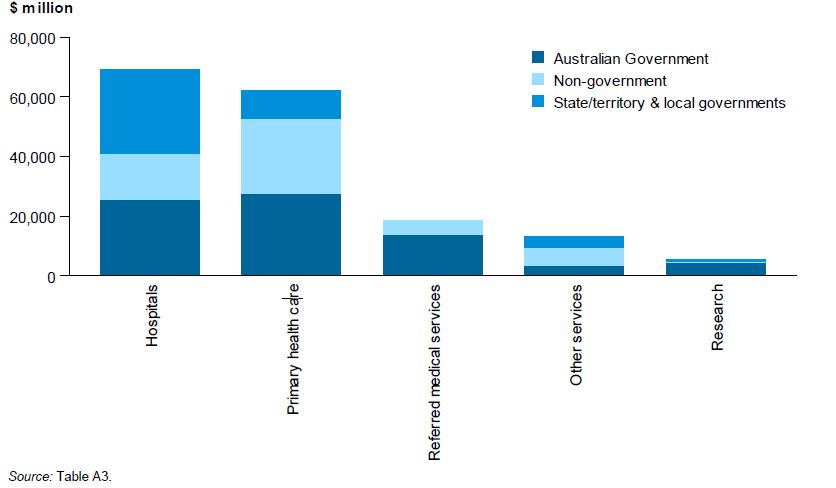
**The Industry**

In 2016–17, Australia invested a record high of $180.7 billion on health, equating to over $7,400 per person, or 10.3 percent of Australia’s GDP (see Figure B.3).[[189]](#footnote-190)

Although a large investor in the sector, Australia’s health system functions at a relatively low cost (as a percentage of GDP) compared to the UK, Canada, US, Germany and Norway, yet outperforms those countries in the vast majority of health status indicators.[[190]](#footnote-191) Furthermore, a recent report ranked Australia’s healthcare system as the second best in the developed world.[[191]](#footnote-192) This evidence would suggest that Australia’s investments in health-care have been well rewarded.

However, real health spending grew by 4.7 percent in 2016–17, 2.6 percent higher than growth in GDP, and the gap between health expenditure and GDP growth in the most recent years is showing signs of widening.[[192]](#footnote-193) This data highlights the importance for the health services sector in Australia not to be complacent, and to prioritise and pursue an innovation agenda.

Two-thirds of the total expenditure (over $120 billion) was spent by Australian governments, with non‑government sources (individuals, private health insurance, and other non-government sources) spending the remaining third. The vast majority of expenditure occurred in hospitals ($70 billion) and primary care (around $65 billion).[[193]](#footnote-194)

Figure B.3: Recurrent health expenditure, current prices, by area of expenditure and source of funds, 2016–17

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Source: Australian Institute of Health and Welfare, [Health expenditure Australia 2016–17](https://www.aihw.gov.au/reports/health-welfare-expenditure/health-expenditure-australia-2016-17/formats)

Australia’s health services system is large and complex. Health spending occurs in different levels of government, as well as by non-government entities, such as private health insurers and individuals. In many cases, funds pass through several entities before providers (such as hospitals, general practices, and pharmacies) use them to provide health goods and services. In Australia, these services are delivered by a variety of government and non‑government providers in a range of service settings that do not have a clearly defined path.[[194]](#footnote-195)

Figure B.4: Client flow within the Australian health-care system

| Figure B.4 (page B38) is a diagram of the complex client-flow in the health-care sector between the health-care providers. General practitioners, hospitals and in-home care are central in the flow of clients that also involve pharmacies, specialists, pathologists, dentists and allied and community healthcare providers. |
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Source: Productivity Commission, Report on Government Services, 2019

Health services are provided by a variety of organisations and individuals, including medical and allied health professionals, hospitals, medical insurers, specialised clinics, and government and non-government agencies. Together, they deliver a wide range of services, from public health and preventative services in the community, to primary health care, emergency health services, hospital-based treatment, mental health and rehabilitation, and palliative care.[[195]](#footnote-196)

These health services are supported by many other agencies. For example, research and statistical bodies provide information for disease prevention, detection, monitoring, diagnosis, treatment, care and associated policy; consumer and advocacy groups contribute to public debate and policy development; and universities and health services (amongst others) contribute to the training of health professionals.[[196]](#footnote-197)

**Innovation**

Business R&D expenditure varies with the relative size of businesses in the health sector.[[197]](#footnote-198) In the health sector, in contrast to other sectors in Australia, a higher proportion of R&D is performed by medium-sized companies (with   
20–199 employees) and less by large-sized companies (200+ employees) (Table B.5).

Table B.5: Expenditure on R&D by size of business in the health sector

|  | **Health** | **Overall** |
| --- | --- | --- |
| 0–4 people (micro) | 11.3% ($12 million) | 6.4% ($1,062 million) |
| 5–19 (small) | 17.9% ($19 million) | 12.3% ($2,054 million) |
| 20–199 (medium) | 50.0% ($53 million) | 24.1% ($4,008 million) |
| 200+ (large) | 20.8% ($22 million) | 57.2% ($9,535 million) |
| total | 100% ($106 million) | 100% ($16,659 million) |

Source: ABS Cat. No. 8104.0 – Research and Experimental Development, Businesses, Australia, 2015–16

### How innovation occurs in the health services sector

This section outlines how innovation occurs in the health services sector and highlights some of the measurement implications arising from these activities.

**The focus is on improving patient outcomes and efficiency**

To understand what drives innovation in the health services, we must first understand the primary aims of the sector. These aims are inextricably linked, which are to:

* *Improve client or patient outcomes*. Innovation clearly benefits the individual, but also the community as a whole, because a healthier population means greater workforce participation and national productivity. The service provider also benefits as if patients are satisfied, the organisation will be attractive to new customers
* *Improve efficiency*. Creation of a more effective and efficient health system reduces – or limits increased rates of – health expenditure as a percentage of GDP, allowing resources to be directed to other activities. Furthermore, for businesses, providing equivalent health services at a reduced cost allows costs-savings to be directed to other initiatives to improve customer or patient outcomes.

The drivers, on the other hand, are conditions, resources or components that encourage an organisation to innovate. The drivers of innovation include (but are not limited to):

* increased demand or pressures on health-care resources (e.g. an ageing population)
* digital and technological advancement or disruption (e.g. introduction of new software, such as patient information management systems that lead to changes in processes)
* availability of improved therapeutics, such as new medications and devices
* changes in government policy or legislation (e.g. pricing regimes and My Health Record)
* a shortage of health professionals in rural and remote communities.

**There is an incomplete picture of innovation in the sector**

Innovation in the health services sector takes place within a complex and dynamic ecosystem that includes hospitals, primary care, allied health and specialist clinics. Services are delivered by government and non‑government providers in a variety of settings and involve several actors that each play an important role in the sector, including researchers, clinical staff (e.g. doctors and nurses), support staff (e.g. administrators and cleaners), specialist allied health professionals, medical insurers, and government regulators and funders.

Innovation within the system also relates to the use of many different types of health interventions, including: drug therapies, surgical procedures, devices and tests, health professional training, patient education, and management, financing and service delivery models, and population health interventions. These interventions will often be required to occur simultaneously, and in harmony with each other, if the desired health outcomes are to be achieved.

The Australian Institute of Health and Welfare (AIHW) reports that approximately three percent of total health expenditure is spent on research.[[198]](#footnote-199) However, we have limited understanding of the proportion that is spent on innovation, as there is currently no source of aggregated national data on innovation in health. One reason for this is that government accounts for roughly two-thirds of the total health expenditure, and innovation in the public sector is currently not included in measurement (for example, it is not captured by innovation-related surveys, such as the ABS’ BCS).[[199]](#footnote-200) Therefore, to measure total innovation occurring in the health services sector, it is important to account for public sector innovation. It is worth noting in this context that the OECD is considering developing a measurement manual specifically for the government sector. Furthermore, experimentation with public sector innovation indicators is ongoing, with large-scale surveys in Norway and Denmark, and the European Co-Val survey initiated in February 2019.[[200]](#footnote-201)

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| **Measurement implications**   * The health services ecosystem is complex and involves a variety of actors in the public sector, non-profit and private sector organisations * Innovation that occurs within the public sector is not captured by innovation-related surveys, such as the ABS BCS. Some of it is captured in the Higher Education and Government R&D expenditure estimates. |

**Success is measured differently to other sectors**

The primary focus of improving patient outcomes raises the question of whether innovation in health is comparable with other sectors. The measurement of innovation in health has several known challenges:

*The health-care product is ill-defined, the outcome of care is uncertain, large segments of the industry are dominated by non-profit providers, and payments are made by third parties, such as the government and private insurers. Many of these factors are present in other industries as well, but in no other industry are they all present. It is the interaction of these factors that tends to make health-care unique.[[201]](#footnote-202)*

Many organisations have developed internal dashboards of metrics relevant to their business needs. The purpose of dashboards is two-fold: to improve patient and client outcomes; and to manage the affordability of health-care responsibly (e.g. reduce the cost-base and minimise unnecessary overheads). Dashboards help businesses in tracking their investment in innovation activities and identifying the returns. The capital savings made by the business are then often re-invested in other initiatives that aim to improve client (or patient) satisfaction.

Clinical indicators are commonly used in combination with engagement metrics as proxies for evaluating economic outcomes. These indicators are collected nationally and reported to clinical quality registries (e.g. joint registry, cardiac registry), which enables health service providers to benchmark clinical outcomes against market performance.

Engagement metrics include Net Promoter Scores (NPS) to measure the satisfaction of the client, are also important for measuring staff satisfaction. If collected, they are only used internally by the organisation and are not reported externally. The Productivity Commission’s 2107 report ‘Shifting the Dial’ recommended that development of national benchmarks for gauging the relative performance of health care providers would be valuable in reducing inconsistencies that exist within multiple hospital and other satisfaction and experience surveys.[[202]](#footnote-203)

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| **Measurement implications**   * Innovations in the health services sector are difficult to measure, both conceptually and statistically, and in a way that is useful for government policy and program development * Internal dashboards commonly include engagement metrics in combination with clinical indicators, and are considered proxies for economic outcomes. Inconsistencies exist with multiple satisfaction and experience surveys, and there are currently no benchmarks for gauging the relative performance of health-care providers nationally. |

**Implementing innovation takes time due to its variability and complexity**

Successful innovation in the sector involves, among other things, evaluation and demonstration of the cost-effectiveness of the innovation being introduced.[[203]](#footnote-204) The introduction of health service innovations must also take into account issues, such as: whether a given innovation is worth introducing (the value proposition); who will benefit; and how to minimize unintended consequences.

The processes involved in introducing innovation include adoption, implementation, maintenance, diffusion, dissemination and expansion. These factors overlap in complex ways, which means that health service innovation is almost never straightforward. Increasingly, innovation also involves the development, introduction and mainstreaming of new technologies.[[204]](#footnote-205)

The timeframe for implementation of innovation is highly variable, and depends largely on the scale and length of time for relevant outputs to be known or assessed. Large organisations that have multiple operations or site locations commonly initiate projects as proof of concept or pilot programs, before deciding whether to undertake a large-scale roll out. These larger private companies also commonly have budget allocations set aside for innovation-specific activities, including prototype development and market testing. When innovations are rolled out to multiple sites, it typically takes one to three years before the results and impacts are measurable.

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| **Measurement implications**   * The timeframe for implementation of innovation is highly variable, and depends largely on the scale and the length of time for relevant outputs to be known or assessed. It typically takes one to three years before the results and impacts are measurable. |

**Most innovation activity is conducted within the organisation**

Core R&D in the health services sector is almost always performed in-house, and is relatively small in scale compared to other health-related industries such as the pharmaceutical sector.

In organisations that consist largely of medical and allied health professionals, R&D activities are commonly integrated into ongoing operations and undertaken by employees who are also providing services to patients. These organisations also commonly have close links to the research sector, with R&D activities largely occurring in collaboration between the organisation and a university. R&D is not likely to be adequately captured by current metrics because it is often driven by small teams, who are also providing services to patients and conducting R&D ‘on the side’. This finding is consistent with innovation in services more broadly, where innovation is largely undertaken by employees that are not classified as researchers, making it harder to measure innovation inputs.[[205]](#footnote-206)

R&D in the health services sector generally has few regulatory requirements to meet, compared to other medical sectors or the pharmaceutical industry, making R&D innovations relatively simple to trial in health services. However, the key disadvantage of less stringent regulation is that the evidence base may be insufficient to measure the long-term effectiveness and impacts of the innovation.

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| **Measurement implications**   * Most R&D is performed in-house. R&D activities may be integrated into ongoing operations and undertaken ‘on the side’ by employees who are also providing services to patients, making the adequate capture of R&D inputs and outputs more difficult. |

**Process innovation is hard to measure and often overlooked**

A significant amount of innovation within the health services is seen in processes involving incremental changes and modifications. This type of innovation commonly involves either the cessation of activities that were unnecessary, encouraging an increase in procedures that already exist but are not well used, or reorganising existing resources. This type of innovation commonly arises in response to the identification of “pain points” signalled by customers, patients or staff. These changes may also be transformational for the organisation, such as the redesign of workflow and rostering.

These types of innovations are considered fairly straightforward and simple to implement, as they have to meet few, if any, regulatory requirements, but can have significant impacts. Specific examples provided by one company include:

* Introducing an environment cleaning ‘bundle’ to reduce infections in hospitals. Each hospital received a bundle of recommendations, including information on optimal cleaning agents, cleaning frequency, staff training on environmental cleaning, and a hospital-wide commitment to improved cleaning
  + These changes led to benefits beyond reducing the level of infections in each hospital. The trial resulted in a cultural change in the hospitals, with 66 percent of cleaning staff reporting they felt more valued after the trial, and 70 percent of respondents feeling their own cleaning work had improved. The trial also promoted collaboration within the hospitals (e.g. between cleaning services and infection control staff)
* Improving risk assessments of patients reporting unspecified chest pain when they presented at hospital emergency departments. Some of these patients are at low risk and could be sent home quickly
  + Through this innovation, unnecessary hospital admissions are avoided, there is less duplication of staff activities, and pressure is reduced for urgent care services
  + There are 70,000 presentations to the emergency department at one Queensland hospital each year, with close to one-third related to chest pain
  + Improved risk assessments could save over 800,000 staff hours across Queensland each year, and release $29 million in resources.

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| **Measurement implications**   * A significant amount of process innovation is evident across the health services sector. The impacts and outputs of these types of innovations are often unmeasured or difficult to measure. |

**There is a significant amount of non-R&D innovation activity**

A significant amount of innovation in the health services involves non-R&D activities, with some organisations estimating an equal split of R&D and non-R&D investment. IT-related, non-R&D innovation common in the sector includes the development of new software, such as electronic discharge summaries and automation of financial services. Other non-R&D activities in the sector include marketing, innovation management and staff development.

Fee-for-service arrangements are generally rare, but are likely to be used when specialist skills and knowledge from outside of the organisation are required (for example, digital health infrastructure and platforms). The companies engaged to perform this type of work are typically small, with fee-for-service the only option available.

**Most organisations in the sector focus internally for sources of innovation**

Evidence of organisations sharing knowledge in the health services sector is limited. Innovations arising within a particular hospital, for example, are seldom shared outside of the individual institution or regional network. A culture of competitiveness was cited as a reason that contributes to a limited sharing of knowledge. This is concerning, given that such sharing is likely to contribute to improved patient outcomes, which is the primary aim of innovation within the sector. The source of funding was another contributing factor, with projects that received funding from a national body, such as the National Health Research Council, considered more likely to publish results than projects funded by state or local Governments, or by the private sector.

However, there are a few organisations that recognise the value in providing a better service for their clients, and seek to enter collaborations in the form of venture partnership arrangements.

There is also evidence of strong links between the university research sector and specialist providers, as well as with hospitals. The publishing of papers and attendance at conferences are considered an important way to contribute to the sharing of knowledge, especially for medical and allied health professional staff. However, some concerns were raised with the ability of staff to attend forums, such as conferences, due to resourcing limitations.

Much of the sector is limited to internal sources of innovation. The organisations interviewed for the sectoral study advised that there are only a few large organisations sourcing innovation from overseas, and domestic competitors are rarely viewed as a source of new ideas. The measurement of health-care output based on volume, rather than quality, was considered an impediment to innovation for businesses in the health services sector.

**Data needs to be used better to maximise its value**

The Australian Institute of Health and Welfare (AIHW) is the primary source of national data on the health services sector. Australia’s health information and data environment is changing rapidly, and while a large volume of data is already collected, some potentially valuable information is missing. This includes data on innovation metrics.

One of the reasons could be that collection of data is seen as additional to core activities, such as prescribing medications or performing procedures. The Productivity Commission’s 2017 report ‘Data Availability and Use’ cited some key factors that often act as blockages to data exchange in health.[[206]](#footnote-207) This includes limited incentives for health service providers to undertake such exchanges, entrenched models of practice that do not facilitate greater use or exchange of data within their service delivery, and in many cases, providers face an array of governance and other requirements that actively prevent them from exchanging data. These factors were confirmed by companies interviewed for the sectoral study. Private sector organisations, in particular, highlighted the lack of incentives to collect and report data, with the government’s ability to collect such data largely dependent on whether businesses see value in participating.

In addition to data not currently being collected, there are also opportunities to improve the use of existing data, including data linkage. Unlike most OECD countries, Australia does not routinely use linked data to monitor the quality of its healthcare system.[[207]](#footnote-208) Linked datasets are valuable, particularly for research and analysis purposes. Although there are linking bodies in all jurisdictions, such as the Population Health Research Network (which brings together data from all states and territories), their use is limited and potential value is yet to be realised.[[208]](#footnote-209)

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| **Measurement implications**   * Innovation-relevant data (if collected) is seldom shared outside of an organisation due to a number of factors, including a lack of incentive for collection and reporting. National data on innovation activities to inform government investment is lacking * Australia, unlike most OECD countries, does not routinely use linked data to monitor the quality of its healthcare system. Linked datasets (which brings together data from all states and territories) would provide opportunities to make better use of existing data. |

## Finance and Insurance Services

### Summary of findings

* Misunderstanding key concepts of innovation may lead to underreporting in surveys of the financial sector
* Since many businesses work together in arrangements where one party is engaged on a fee-for-service basis, current measures of collaboration based on the Oslo Manual definition (which excludes fee-for-service contracts) do not capture the full extent of co-operative activities occurring in the financial sector
* The sector operates in a highly competitive market, and a significant proportion of fintech-related innovation and capability is sourced from overseas
* Due to the digitalisation of the sector, in principle there is significant granularity possible in mapping the components of innovation, particularly intangible assets
* Unlike other sectors, measuring innovation over the course of a year is sufficiently long enough for the financial sector as innovation progresses from idea to full implementation very quickly
* There is significant potential for innovation in the sector to spillover into other areas of the economy
* Current measurement does not consider innovation that creates social benefits. Environmental and social changes are key to living standards and therefore need to be measured effectively to improve our understanding of the impacts of innovation.

### Summary of opportunities

* Misunderstandings about the concepts of innovation should be addressed by including sector-specific explanations and examples in survey instruments
* Measurement of social and environmental benefits of innovation that are not typically quantified in innovation measurement should be considered
* There should be analysis of collaborative arrangements that are occurring on a fee-for-service basis
* Due to the digitalisation of the sector, opportunities should be investigated to capture data that improves measurement of intangible innovation.

### Background and context

**The industry**

The financial sector is made up of businesses from the banking, financial planning, insurance and superannuation fund areas. For the purposes of this study, they have been collectively addressed as the financial sector.

The finance sector in Australia has some of the largest banks in terms of market capitalisation, and are regarded amongst the safest institutions in the world.[[209]](#footnote-210)

At the end of the 2017–18 financial year, there were 209,621 companies operating in the sector, which represented nine percent of the total number of businesses in Australia.[[210]](#footnote-211) However, the vast majority of these (around 99 percent) are either non-employing businesses (173,723), micro financial sector companies with fewer than five employees (30,241) or small businesses with 5–19 employees (4,415). There was a higher proportion of non-employing businesses in the financial sector (82.9 percent) than for the rest of the Australian economy (61.2 percent).

During this period, there were only 184 large companies in the financial sector. This sector is similar in profile to the agriculture sector in that there are a large number of businesses overall but relatively few large businesses. The sector also comprises a majority of wholly Australian-owned businesses (95.3 percent).

**Innovation**

Innovation in the financial sector is considered a key element for success. Of innovation active financial businesses, 48.1 percent had increased revenue in the past year.[[211]](#footnote-212) In comparison, only 31.1 percent of non-innovation-active businesses had an increase in revenue. Businesses surveyed by the BCS in the financial sector indicated they are more likely to source innovation internally, and from clients, than the industry average. Universities are seen as a very small source of innovative ideas.[[212]](#footnote-213)

The financial sector made a significant contribution to business expenditure on R&D (19 percent of total BERD in 2015–16).[[213]](#footnote-214) This research intensity is reflected in the Analytical Business Enterprise Research and Development (ANBERD) data in Figure B.5 that shows the Australian financial sector is a leading sector internationally in terms of R&D intensity (ranking third out of   
31 countries).

Figure B.5: Comparison of R&D intensities in the financial sector in the OECD (2018)

| Figure B.5 (page B49) is a bar graph comparing the R&D intensity across 31 OECD countries in their respective financial sectors. Denmark is a clear leader in R&D intensity with a group of countries that include Greece, Australia (3rd), Portugal, Finland and Estonia, with roughly half the digital intensity of Denmark, coming next. |
| --- |

Source: OECD, ANBERD (Analytical Business Enterprise Research and Development) database

In addition, business R&D is overwhelmingly performed by large businesses in the financial sector.[[214]](#footnote-215) They contributed 87.7 percent of R&D expenditure by all financial sector companies in 2015–16.

Table B.6: Expenditure on R&D by size of business in the financial sector

|  | **Finance** | **Overall** |
| --- | --- | --- |
| 0–4 people (micro) | 1.8% ($57 million) | 6.4% ($1,062 million) |
| 5–19 (small) | 2.3% ($75 million) | 12.3% ($2,054 million) |
| 20–199 (medium) | 8.2% ($264 million) | 24.1% ($4,008 million) |
| 200+ (large) | 87.7% ($2,820 million) | 57.2% ($9,535 million) |
| total | 100% ($3,215 million) | 100% ($16,659 million) |

Source: ABS Cat. No. 8104.0 – Research and Experimental Development, Businesses, Australia, 2015–16

The RDTI is an initiative by the Australian Government to encourage companies to engage in R&D.[[215]](#footnote-216) The initiative provides a tax offset to Australian companies to claim the cost of eligible R&D activities. In 2017, $642 million (4.6 percent of the total) was claimed by the financial sector through the RDTI.

The vast majority of this R&D (91.9 percent) was in areas of computer software, information systems and information and computing sciences. From this breakdown, it is apparent there is heavy investment in digital infrastructure R&D that may have spillover benefits in other technology sectors.

### How innovation occurs in the financial services sector

This section outlines how innovation occurs in the financial services sector and highlights some of the measurement implications arising from these activities.

**Greater clarification is needed on key concepts of innovation**

There are various interpretations of what ‘significantly different’ means from the perspective of a new product and process counting as innovation (as set out in the Oslo Manual). Some respondents set the bar high, identifying only what may be termed radical innovation, while others included minor process improvements (which would also be included in the Oslo classification). While the ABS avoids using the term innovation in its surveys, there was similar disparity in views about what constitutes a ‘new’ product or process.

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| **Measurement implications**   * Misunderstanding may lead to underreporting of innovative activities in surveys of the financial sector. |

**Collaboration varies in the sector and is based on trust**

Collaboration is important as it allows the diffusion of knowledge and sharing of risk and capabilities. In the financial sector, there are various points of view regarding the level of trust in the sector. Trust significantly influences the ways in which businesses collaborate.

Larger businesses advised that they engage in various types of collaboration. Some include true collaborative partnerships with sharing of new IP. Other partnerships are with current and prospective clients through research and feedback on products and services. Some businesses reported significant levels of collaboration through financial transactions, although they indicated it would be difficult to track across the organisation and measure effectively. One company advised that investment in start-ups was viewed as a form of collaboration to bring innovative products and services to market. However, most companies advised that the majority of collaboration was conducted through fee-for-service arrangements.

It was noted in interviews that collaboration with overseas companies was often seen as more beneficial than domestic partnerships. Singapore was highlighted as a particularly open country for engagement. One company advised that there was goodwill with other international businesses in the sector, even when there were no financial transactions taking place.

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| **Measurement implications**   * Since many businesses work together in arrangements where one party engages on a fee-for-service basis, current measures of collaboration based on the Oslo Manual definition (which excludes fee-for-service contracts), do not capture the full extent of co-operative activities occurring in the financial sector. |

**The financial services sector is a highly competitive international market**

Other countries provide a significant source of innovation for the Australian financial services sector. A number of companies seek to leverage the capability of big businesses and technology businesses based overseas in developing financial technology (fintech) systems. China, in particular, was identified as a major player due to the scale of innovation occurring, and also Singapore, for its receptive regulatory environment. From a digital banking perspective, one company noted that there are strong developments in Europe that could be emulated, but the Australian sector has close comparisons to technology developments in the Americas.

In relation to the recruitment of staff, companies compete in an internationally competitive market for resources. They seek to secure the best resources possible, both domestically and internationally. Recruitment of overseas staff was described by some companies as a key means of increasing capability, especially in the digital technology area. While finance is the key activity of the companies interviewed, all businesses reported the critical need for staff with specialist digital capabilities.

Businesses interviewed for the sectoral study reported that most of the relevant learning took place as on-the-job training, or learning by doing. Formal training was not identified as a significant input.

**Digital technology is a significant source of intangible assets**

Digital technology is a critical enabler for the financial sector. A large share of innovation comes from the digitalisation of current processes. Other types of innovation involve the creation of new mathematical models for risk and pricing. These activities, along with patenting, provide a significant source of intangible assets.

As an example of digitalisation in the sector, Lendi is an Australian online home loan platform that matches borrowers and loan products. Lendi combines smart technology with more traditional forms of support to make it easier to search, choose and settle a home loan online. Lendi has influenced banks to adopt more digital processes (and become partners with the business) through its work in online identification and verification.[[216]](#footnote-217) Digitising processes has significantly reduced the time it takes to process online home loan applications (e.g. from several months to several weeks). However, there is ongoing work in the fintech sector to reduce this even further. One company advised it is seeking to develop a process that completes mortgage applications in a matter of minutes.

Innovation has helped drive the increasing personalisation of products and services. Businesses such as Netflix and Google, are shaping expectations in other sectors around the quality, speed and tailoring of services. These expectations significantly impact consumer expectations of financial services. From a measurement perspective, this means in principle that significant granularity is possible in mapping the components of innovation in financial services businesses.

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| **Measurement implications**   * Due to the digitalisation of the sector, in principle there is significant granularity possible in mapping the components of innovation, including intangibles. |

**Innovation is going beyond economic outcomes to deliver wider social benefits**

The drivers of innovation in the financial sector are closely aligned with economic outcomes. In particular, a number of banks estimated almost 50 percent of expenditure on innovation was driven by the need to respond to regulatory change. This included the costs involved in maintaining IT capabilities and reporting systems. One bank advised that maintaining the integrity of their compliance and regulatory reporting obligations were important factors in their innovative activities.

Evolving customer demand was considered the overwhelmingly agreed upon driver of innovation in the financial sector. All participants in the review indicated that gaining and retaining new and existing customers was of paramount importance to their business. As a result, the financial wellbeing of customers was becoming a significant consideration in driving innovation. The goal is to encourage customers to adjust spending habits and make better choices that will improve their finances over the longer term. For example, Xinja’s mission is to build a bank with its customers, designed in their interests that helps them make better money decisions without the angst.[[217]](#footnote-218)

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| **Measurement implications**   * There is no quantifiable measure of social benefit (such as improved financial wellbeing) from innovations that restrict undesired behaviours, such as problem gambling and excessive alcohol consumption (for example by limiting ATM withdrawals or credit card payments at particular locations or times at the customer’s request). |

**Not all innovation is being reported and measured**

All businesses interviewed reported undertaking R&D. A significant share of this activity was the adaptation of existing systems and products to the Australian context, which is ineligible to be claimed under the RDTI based on current criteria. As a result, there is a large gap between the R&D activity being conducted and what can be claimed through this program. Many businesses advised that the RDTI did not significantly influence their R&D expenditure. Their R&D activity was conducted mostly, and in many cases exclusively in-house.

Not all innovation is short-term, although short-term innovation appeared to be much more common than long-term innovation this sector. IAG has been conducting R&D to prepare for the implementation of autonomous vehicles for many years.[[218]](#footnote-219) This research could have impacts that go far beyond purely economic, which are very difficult to measure and may take time before outcomes are known.

Due to the financial sector’s large digital focus, and mostly short-term focus, feedback on the impacts of innovation occurs much more quickly than in other sectors.

One bank indicated that a lot of digital service offerings are related to financial wellbeing and enhancing the use of its products.

Customer satisfaction is considered a very important measure. It was noted that all businesses interviewed were able to measure this with great accuracy due to the digital nature of the products and services offered. Customer satisfaction is not the same as improved financial wellbeing.

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| **Measurement implications**   * Some innovation in the financial sector is long-term in nature, and is conducted to enable an appropriate response to major technological change enabling business survival, rather than increasing revenue or reducing costs in the short to medium-term. This innovation is not hidden, but it is difficult to assess its impact. |

**Innovation moves quickly from concept to implementation**

Innovation in the sector is characterised by short cycles and lends itself well to agile management approaches. The reference period for innovation was generally reported to be less than a year, more commonly six months or less, and sometimes in the order of weeks. For example, Macquarie Bank implemented an agile methodology across its digital operations in 2017.[[219]](#footnote-220) This enables adjustments to be made every two weeks, based on feedback from both staff and early adopting consumers. Macquarie now feels better placed to compete in a digital economy and respond to unexpected competition. In order to realise this shift, Macquarie Bank made a large investment in human capital.

A number of other banks advised they had also implemented agile methodologies across the business to help reduce timeframes and improve digital services for customers. All companies interviewed for the sectoral study considered agile approaches to project management to be a key form of organisational innovation.

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| **Measurement implications**   * Unlike other sectors, measuring innovation over a year is generally long enough for the financial sector as innovations go from idea to full implementation very quickly. |

**There is significant potential for spillover benefits**

Several businesses reported significant knowledge spillovers as a result of their innovation. As discussed earlier, Lendi has influenced banks to adopt processes for faster mortgage applications and home loans through its development of online identification processes. It was often noted in interviews that innovation in the sector has great potential to generate benefits in other areas of the economy.

For example, Macquarie Bank has launched an online tool to help support the independent financial adviser industry.[[220]](#footnote-221) Independent financial advisers are able to service clients better using the platforms that Macquarie provides. It allows them to advise clients more efficiently on issues such as self-managed superannuation funds, mortgages, online trading, investments, managed accounts, and improved overall record-keeping. Macquarie does make revenue from the provision of the platform, but it allows others to generate profit from the service.

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| **Measurement implications**   * There is significant potential for innovation in the sector to spillover into other areas of the economy. |

# Appendix C: Updated improving innovation indicators consultation paper 2019, following the public submission process

# Appendix D: Innovation Metrics Review Workshop Proceedings 13–14 March 2019

# Appendix E: ATSE’s Innovation Metrics Review literature review

# Appendix F: Compendium of metrics

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| Key points   * The Innovation Metrics Compendium documents which existing metrics the Review considered * The Innovation Metrics Compendium is used to demonstrate the degree of coverage provided by existing metrics. |

## Purpose

This Innovation Metrics Compendium was developed in order to provide an indication of:

* the quantum of metrics currently available relating to various areas of the innovation system
* how usable and reliable those metrics are.

A key purpose in undertaking this work was to determine if – and if so, on what topics – the Review needed to develop new indicators on, based on the Review framework, either because there were gaps in coverage or significant quality issues associated with existing metrics.

Where possible, the Review used the best existing metrics available. Existing metrics are more likely to be collected by other countries and thus support international comparison.

This table of metrics shows only the classification of metrics against the Innovation Metrics Review Framework discussed in the Review process and methodology. As indicated in the Review process and methodology, the Review also considered the quality of metrics against assessment criteria developed by the Review.

The assessment of metrics within the framework has not been published, as the Review considered only whether each of the metrics were fit for Australian purposes.

## Caveat

| This document and the assessment of how fit for Australian purposes each of the metrics are should be considered as permanently in progress. This is because:   * there is a large (and, arguably, almost inexhaustible) supply of metrics that could be added to the Compendium, beyond the 597 considered here * it can take hours, or even days, to evaluate even a single metric thoroughly and comprehensively.   As a consequence of the above, the time necessary to perform both a comprehensive and thorough analysis of existing metrics was well beyond that available to the Review. Therefore, the contents of this Compendium should be considered as indicative and provisional. |
| --- |

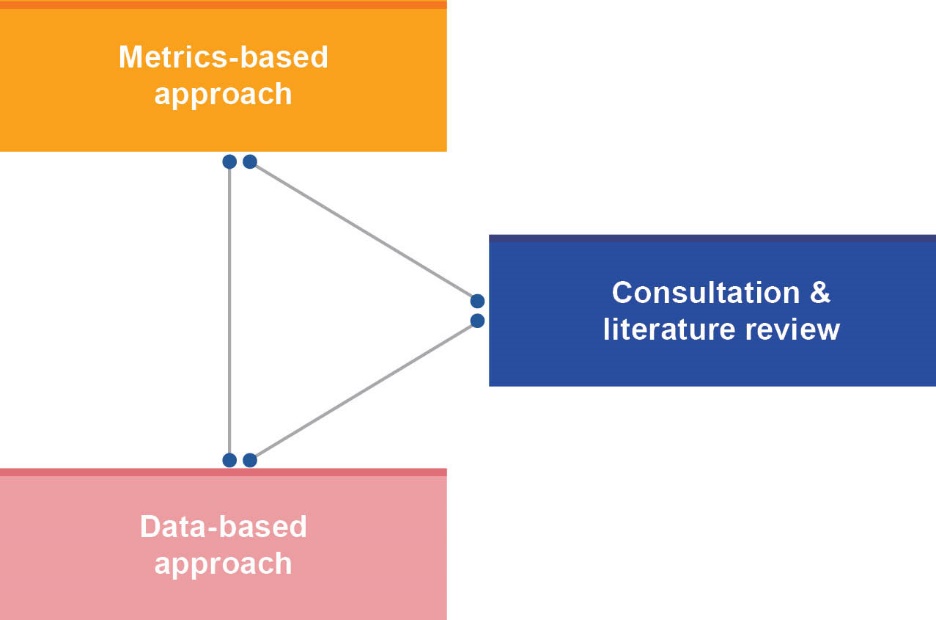
## Structure

The structure of the Compendium is provided by the Innovation Metrics Framework discussed in the Review process, and methodology that was developed as part of the Review. This Framework was then populated using a triangulation approach, as shown in Figure F.1. Two types of metrics were sourced:

* established metrics – metrics that are currently in use for measuring innovation system performance
* data sources identified by the Review.

The included metrics were identified in a variety of ways, but most notably based upon:

* their regular use within DIIS
* their identification during consultations, discussions and desk-based research undertaken as part of the Review.

Figure F.1: Triangulation approach to identifying metrics to populate the innovation metrics compendium against the Review’s innovation framework

The Compendium includes the following columns:

* Type: This column indicates the type of metric that has been included (i.e. Established or Data sources). Established metrics are labelled with the metrics collection that they were sourced from (e.g. Global Innovation Index (GII); OECD Main Science and Technology Indicators (MSTI); OECD STI Scoreboard (STIS)). A glossary linking labels with metric source titles is included below
* Metric: This column provides a summary description of the metric or data source. More detailed information about the data upon which a metric is based – and how it was calculated – should be sought from the listed source (refer Note 1 and Note 2 below)
* Data source: This column provides detail on the data sources that underpin the metric, or other descriptive information.

Table F.1: Glossary of included data sources

| ABS | Australian Bureau of Statistics |
| --- | --- |
| AISR | Australian Innovation Systems Report |
| ARC | Australian Research Council |
| ARTG | Australian Register of Therapeutic Goods |
| CRC | Cooperative Research Centre |
| DET | Department of Education, Science and Training |
| DIIS | Department of Industry, Innovation and Science |
| EAAG | OECD Entrepreneurship At A Glance |
| EIS | European Innovation Scoreboard |
| EP | Entrepreneurs’ Programme |
| GCR | Global Competitiveness Report |
| GII | Global Innovation Index |
| HDI | Human Development Index |
| HEFP | Higher Education Finance Publication |
| HERDC | Higher Education Research Data Collection |
| IC | Innovation Connections |
| IPA | IP Australia |
| ISA 2016 | Innovation and Science Australia (ISA), Performance Review of the Australian Innovation, Science and Research System |
| ISA 2018 | ISA Australia 2030 Prosperity through Innovation |
| MSTI | OECD Main Science and Technology Indicators |
| NCVER | National Centre for Vocational Education Research |
| NSRC | National Survey of Research Commercialisation |
| QILT | Quality Indicators for Learning and Teaching |
| PMR | OECD’s Product Market Regulation |
| RDTI | Research and Development Tax Incentive |
| RRDC | Rural R&D Corporations |
| SRIBT | Science, Research and Innovation Budget Tables |
| STIS | OECD Science, Technology and Innovation Scoreboard |

## Note 1

In some instances, the name of a metric includes identifying information from the source (e.g. an index number). This information is included to make it easier to locate that metric within the source documentation.

## Note 2

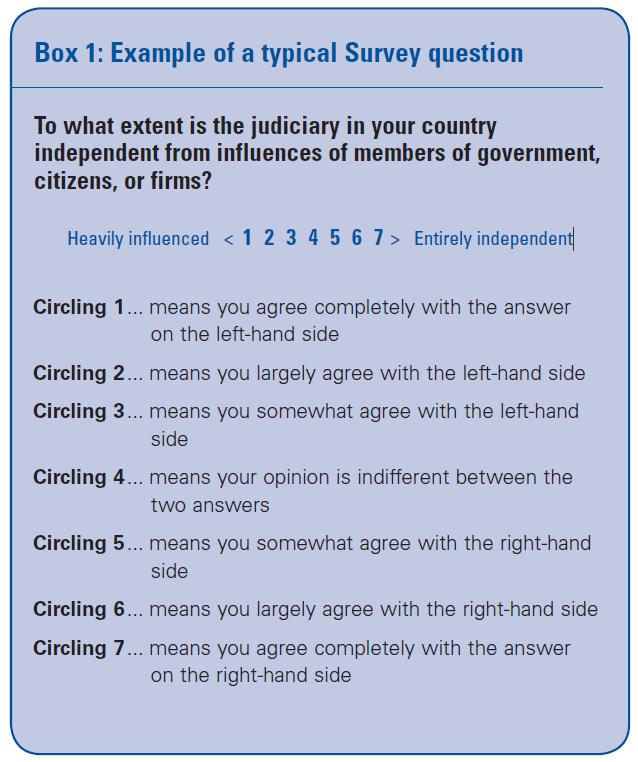
Metrics drawn from the Executive Opinion Survey and other similar surveys are based upon questions with the following type of structure:

Table F.2: Compendium of metrics

| Type | Metric | Data source |
| --- | --- | --- |
| 1 | OPERATING ENVIRONMENT |  |
| 1.1 | Domestic governance and institutional environment |  |
| PMR | Public ownership | OECD Product Market Regulation database. |
| 1.1.1 | Political environment |  |
| GII | 1.1.1 Political stability & safety | World Bank, Worldwide Governance Indicators, 2016 update. (<http://info.worldbank.org/governance/wgi/index.aspx#home>) |
| GCR | 8.06 Workers’ rights | International Trade Union Confederation (ITUC); World Economic Forum (WEF). (see Note 2) |
| GCR | 1.05 Social capital | Legatum Institute. |
| GCR | 1.14 Incidence of corruption | WEF, Executive Opinion Survey. (see Note 2) |
| 1.1.2 | Legislative and regulatory environment |  |
| PMR | Product market regulation | OECD Product Market Regulation database. |
| PMR | Distortions induced by state involvement | OECD Product Market Regulation database. |
| PMR | Involvement in business operations | OECD Product Market Regulation database. |
| PMR | Simplification and Evaluation of Regulations | OECD Product Market Regulation database. |
| ISA 2018 | E-government Index | WIPO, Cornell University, INSEAD: *Section 1.1.2 Government effectiveness* <https://www.globalinnovationindex.org/analysis-indicator> |
| ISA 2018 | Government effectiveness index | WIPO, Cornell University, INSEAD: *Section 3.1.3 Government online services* <https://www.globalinnovationindex.org/analysis-indicator> |
| GII | 1.1.2 Government effectiveness | World Bank, Worldwide Governance Indicators, 2016 update. (<http://info.worldbank.org/governance/wgi/index.aspx#home>) |
| GII | 1.2.1 Regulatory quality | World Bank, Worldwide Governance Indicators, 2016 update. (<http://info.worldbank.org/governance/wgi/index.aspx#home>) |
| GII | 1.2.2 Rule of law | World Bank, Worldwide Governance Indicators, 2016 update. (<http://info.worldbank.org/governance/wgi/index.aspx#home>) |
| GII | 1.3.3 Ease of paying taxes | World Bank, Ease of Doing Business Index 2017: Equal Opportunity for All (2014–16). (<http://www.doingbusiness.org/reports/global-reports/doing-business-2017>) |
| GII | 4.2.1 Ease of protecting minority investors | World Bank, Ease of Doing Business Index 2017: Equal Opportunity for All (2016). (<http://www.doingbusiness.org/reports/global-reports/doing-business-2017>) |
| AISR | ISO 14001 environmental certificates, per billion PPP$ GDP | Cornell University, INSEAD, WIPO (2012–16) Global Innovation Index, GII 2012–16, URL: <http://www.globalinnovationindex.org>; |
| ABS | Adherence to standards, % of respondents | ABS Selected Characteristics of Australian Business, cat. no. 8167.0, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8167.0> |
| ABS | Government regulations or compliance, % of respondents | ABS Selected Characteristics of Australian Business, cat. no. 8167.0, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8167.0> |
| GCR | 7.01 Distortive effect of taxes and subsidies on competition | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 8.02 Hiring and firing practices | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 8.05 Active labour policies | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 8.07 Ease of hiring foreign labour | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 1.04 Reliability of police services | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 1.06 Budget transparency | The World Bank Group. (see Note 2) |
| GCR | 1.07 Judicial independence | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 1.08 Efficiency of legal framework in challenging regulations | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 1.13 Future orientation of government | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 1.15 Property rights | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 1.16 Intellectual property protection | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 1.17 Quality of land administration | The World Bank Group. |
| GCR | 1.18 Strength of auditing and reporting standards | WEF, Executive Opinion Survey. (see Note 2) |
| 1.1.2.1 | Entry and exit barriers |  |
| GII | 1.3.1 Ease of starting a business | World Bank, Ease of Doing Business Index 2017: Equal Opportunity for All (2014–16). (<http://www.doingbusiness.org/reports/global-reports/doing-business-2017>) |
| GII | 1.3.2 Ease of resolving insolvency | World Bank, Ease of Doing Business Index 2017: Equal Opportunity for All (2014–16). (<http://www.doingbusiness.org/reports/global-reports/doing-business-2017>) |
| PMR | Barriers to domestic and foreign entry | OECD Product Market Regulation database. |
| PMR | Administrative burden on start-ups | OECD Product Market Regulation database. |
| AISR | Start-up procedures to register a business, count | World Bank (2017) World Development Indicators, 2017, URL: <http://data.worldbank.org/>; |
| AISR | Cost of business start-up procedures, % of GNI per capita | World Bank (2017) World Development Indicators, 2017, URL: <http://data.worldbank.org/>; |
| GCR | 11.01 Cost of starting a business | The World Bank Group. |
| GCR | 11.02 Time to start a business | The World Bank Group. |
| GCR | 11.04 Insolvency regulatory framework | The World Bank Group. |
| 1.1.3 | Taxation environment |  |
| GCR | 8.12 Labour tax rate | The World Bank Group. |
| 1.1.4 | Financial environment |  |
| GCR | 9.06 Soundness of banks | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 10.01 Gross domestic product | International Monetary Fund (IMF). |
| GCR | 7.02 Extent of market dominance | WEF, Executive Opinion Survey. (see Note 2) |
| GII | 4.3.3 Domestic market scale, billion PPP$ | World Bank, International Monetary Fund, World Economic Outlook Database October 2016 (PPP$ GDP) (2016). (<https://www.imf.org/external/pubs/ft/weo/2016/02/weodata/index.aspx>) |
| HDI | Gross national income (GNI) per capita (2011 PPP $) | World Bank (2018b), IMF (2018) and United Nations Statistics Division (2018b). |
| HDI | Gross domestic product (GDP) per capita (2011 PPP $) | World Bank (2018a). |
| HDI | Gross domestic product (GDP), total (2011 PPP $ billions) | World Bank (2018a). |
| HDI | Gross fixed capital formation (% of GDP) | World Bank (2018a). |
| HDI | Gross capital formation (% of GDP) | World Bank (2018a). |
| S&P | Standard & Poor (S&P) Sovereign Rating | S&P |
| 1.1.4.1 | Credit |  |
| GII | 4.1.1 Ease of getting credit | World Bank, Ease of Doing Business Index 2017: Equal Opportunity for All (2016). (<http://www.doingbusiness.org/reports/global-reports/doing-business-2017> ) |
| GII | 4.1.2 Domestic credit to private sector, % GDP | International Monetary Fund, International Financial Statistics and data files; and World Bank and OECD GDP estimates; extracted from the World Bank’s World Development Indicators database (2008–15). (<http://data.worldbank.org/>) |
| GII | 4.1.3 Microfinance gross loans, % GDP | Microfinance Information Exchange, Mix Market database; International Monetary Fund, World Economic Outlook Database, October 2016 (current US$ GDP) (2007–15). (<https://reports.themix.org/>; <https://www.imf.org/external/pubs/ft/weo/2016/02/weodata/index.aspx>) |
| AISR | Ease of access to loans, score ranges from 1–7 (best) | WEF (2014–17) Global Competitiveness Index, 2014–15 to 2017–18, URL: <http://www.weforum.org/> |
| GCR, HDI | 9.01 Domestic credit to private sector | The World Bank Group. |
| GCR | 9.02 Financing of SMEs | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 9.08 Credit gap | WEF; calculations based on The World Bank Group data. |
| 1.1.4.2 | Equity |  |
| AISR | Financing through local equity market, score ranges from 1–7 (best) | WEF (2014–17) Global Competitiveness Index, 2014–15 to 2017–18, URL: <http://www.weforum.org/> |
| ABS | Barrier to innovation: Lack of access to additional funds, % of respondents | 8158.0 – Innovation in Australian Business, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8158.0> |
| ABS | Proportion of businesses seeking debt or equity finance for innovation, % of respondents | 8158.0 – Innovation in Australian Business, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8158.0> |
| GCR | 9.09 Banks’ regulatory capital ratio | The World Bank Group. |
| 1.1.5 | Policy and program environment |  |
| HDI | Ratio of education and health expenditure to military expenditure | World Bank (2018a) |
| 1.1.5.1 | Innovation procurement |  |
| ISA 2018 | Percentage of contracts allocated to SMEs | Australian Government Department of Finance. <https://data.gov.au/dataset/historical-australian-government-contract-data> |
| AusTender | Government procurement including by supplier type and contract amount. | Australian Government Department of Finance. <https://data.gov.au/dataset/historical-australian-government-contract-data> |
| 1.2 | Infrastructure |  |
| 1.2.1 | ICT and digital infrastructure |  |
| EIS | 1.3.1 Broadband penetration | Data source Eurostat, Community Survey of ICT Usage and E-commerce in Enterprises |
| GII | 3.1.1 ICT access | International Telecommunication Union, Measuring the Information Society 2016, ICT Development Index 2016. (<http://www.itu.int/en/ITU-D/Statistics/Pages/publications/mis2016.aspx> ) |
| GII | 3.1.2 ICT use | International Telecommunication Union, Measuring the Information Society 2016, ICT Development Index 2016. (<http://www.itu.int/en/ITU-D/Statistics/Pages/publications/mis2016.aspx> ) |
| GII | 3.1.3 Government’s online service | United Nations Public Administration Network, e-Government Survey 2016. (<https://publicadministration.un.org/egovkb/en-us/Reports/UN-E-Government-Survey-2016> ) |
| STIS | 2. Mobile broadband penetration, Total subscriptions and per 100 inhabitants, 2016 | OECD, Broadband Portal, <http://oe.cd/broadband> and ITU, World Telecommunication/ICT Indicators Database, July 2017 |
| STIS | 3. M2M SIM card penetration, Per 100 inhabitants | OECD calculations based on GSMA Intelligence, September 2017 |
| STIS | 4. Top M2M SIM card connections, Total connections and as a percentage of world total | OECD calculations based on GSMA Intelligence, September 2017 |
| STIS | Diffusion of selected ICT tools and activities in enterprises, by technology, As percentage of enterprises with 10 or more persons employed | OECD, ICT Access and usage by Businesses Database, http://oe.cd/bus, July 2017. |
| STIS | Enterprises engaged in sales via e-commerce, by size, As a percentage of enterprises in each employment size class | OECD, ICT Access and usage by Businesses Database, http://oe.cd/bus, July 2017 |
| STIS | Enterprises using cloud computing services, by size. As a percentage of enterprises in each employment size class | OECD, ICT Access and usage by Businesses Database, http://oe.cd/bus, July 2017 |
| STIS | Mobile broadband penetration, by technology. Per 100 inhabitants | OECD, Broadband Portal, [www.oecd.org/sti/broadband/oecdbroadbandportal.htm](http://www.oecd.org/sti/broadband/oecdbroadbandportal.htm), July 2017 |
| STIS | Households with broadband connections, urban and rural, 2010 and 2016 | OECD, ICT Access and usage by Households and Individuals Database, <http://oe.cd/hhind>, June 2017. |
| STIS | Small and medium enterprises with broadband access, fixed or mobile, 2016 | OECD, ICT Access and usage by Businesses Database, <http://oe.cd/bus>, July 2017 |
| GCR | 1.12 E-Participation Index | United Nations, Department of Economic and Social Affairs (UNDESA). |
| GCR | 3.01 Mobile-cellular telephone subscriptions | International Telecommunications Union (ITU). |
| GCR | 3.02 Mobile-broadband subscriptions | International Telecommunications Union (ITU). |
| GCR | 3.03 Fixed-broadband internet subscriptions | International Telecommunications Union (ITU). |
| GCR | 3.04 Fiber internet subscriptions | WEF calculations based on International Telecommunications Union (ITU). |
| GCR, HDI | 3.05 Internet users | International Telecommunications Union (ITU). |
| HDI | Internet users, female (% of female population) | International Telecommunications Union (ITU). |
| HDI | Mobile phone subscriptions (per 100 people) | International Telecommunications Union (ITU). |
| World Bank | Fixed broadband Internet tariffs, PPP $/month | World Bank (<https://tcdata360.worldbank.org/indicators/etrade.entrp.broadband.tar?country=AUS&indicator=3411&countries=KOR,USA&viz=line_chart&years=2012,2016>) |
| 1.2.2 | Research infrastructure |  |
| XXX | Nil at present | Nil |
| 1.2.3 | General infrastructure |  |
| GCR | 2.01 Quality of road network | WEF’s calculations. |
| GCR | 2.02 Quality of road infrastructure | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 2.04 Efficiency of train services | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 2.05 Airport connectivity | International Air Transport Association (IATA). |
| GCR | 2.07 Liner Shipping Connectivity Index | United Nations Conference on Trade and Development (UNCTAD). |
| GCR | 2.09 Electricity access | International Energy Agency (IEA). |
| GCR | 2.10 Electricity quality | International Energy Agency (IEA). |
| GCR | 2.11 Exposure to unsafe drinking water % pop. | Institute for Health Metrics and Evaluation (IHME). |
| GCR | 2.12 Reliability of water supply | WEF, Executive Opinion Survey. (see Note 2) |
| 1.3 | Business environment |  |
| GCR | 7.03 Competition in services | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 8.10 Pay and productivity | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 11.07 Growth of innovative companies | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 1.10 Burden of government regulation | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 1.11 Efficiency of legal framework in settling disputes | WEF, Executive Opinion Survey. (see Note 2) |
| PMR | Barriers in Service & Network sectors | OECD Product Market Regulation database. |
| 1.3.1 | Business churn |  |
| STIS | Entry and exit rates in ICT and other business sectors, 2013–15, Number of entering/exiting units as a percentage of number of entering/exiting and incumbent units | OECD calculations based on the DynEmp v.2 and v.3 Databases, preliminary data, <http://oe.cd/dynemp>, July 2017. StatLink contains more data. |
| AISR | Churn Rate | ABS 8165.0 Counts of Australian Businesses, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/8165.0> |
| AISR | Employer Enterprise Birth Rate % | ABS 8165.0 Counts of Australian Businesses, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/8165.0> |
| AISR | Employer Enterprise Death Rate | ABS 8165.0 Counts of Australian Businesses, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/8165.0> |
| AISR | 1–year survival rate (employer enterprises) | ABS 8165.0 Counts of Australian Businesses, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/8165.0> |
| 1.3.2 | Diversity |  |
| GII | 1.2.3 Cost of redundancy dismissal, salary weeks | World Bank, Ease of Doing Business Index 2017: Equal Opportunity for All (2014–16). (<http://www.doingbusiness.org/reports/global-reports/doing-business-2017> ) |
| STIS | Share of young micro and small existing firms in ICT and other sectors, 2013–15 | OECD calculations based on the DynEmp v.2 and v.3 Databases, preliminary data, <http://oe.cd/dynemp> , July 2017 |
| STIS | Differences in employment growth between young small and old small firms in ICT and other sectors, 2013–15 | OECD calculations based on the DynEmp v.2 and v.3 Databases, preliminary data, <http://oe.cd/dynemp> , July 2017. |
| GCR | 8.11 Female participation in labour force | International Labour Organization (ILO); WEF. |
| GCR | 12.01 Diversity of workforce | WEF, Executive Opinion Survey. (see Note 2) |
| HDI | Income inequality, Gini coefficient | World Bank (2018a). |
| HDI | Income inequality, Palma ratio | World Bank (2018a). |
| HDI | Income inequality, quintile ratio | World Bank (2018a). |
| HDI | Inequality in education (%) | Calculated based on data from the Luxembourg Income Study database, Eurostat’s European Union Statistics on Income and Living Conditions, the World Bank’s International Income Distribution Database, the Center for Distributive, Labor and Social Studies and the World Bank’s Socio-Economic Database for Latin America and the Caribbean, ICF Macro Demographic and Health Surveys and United Nations Children’s Fund Multiple Indicator Cluster Surveys using the methodology in Technical Note 2 (available at <http://hdr.undp.org/sites/default/files/hdr2018_technical_notes.pdf>). |
| HDI | Inequality in income (%) | Calculated based on data from the Luxembourg Income Study database, Eurostat’s European Union Statistics on Income and Living Conditions, the World Bank’s International Income Distribution Database, the Center for Distributive, Labor and Social Studies and the World Bank’s Socio-Economic Database for Latin America and the Caribbean, ICF Macro Demographic and Health Surveys and United Nations Children’s Fund Multiple Indicator Cluster Surveys using the methodology in Technical (see Note 2) (available at <http://hdr.undp.org/sites/default/files/hdr2018_technical_notes.pdf>). |
| HDI | Female share of employment in senior and middle management (%) | ILO (2018a).; <https://www.ilo.org/ilostat/faces/oracle/webcenter/portalapp/pagehierarchy/Page27.jspx?subject=SDG&indicator=SDG_0552_OCU_RT&datasetCode=A&collectionCode=SDG>; Labor Force Survey |
| HDI | Female share of graduates in science, mathematics, engineering, manufacturing and construction at tertiary level (%) | UNESCO Institute for Statistics (2018). ; <http://data.uis.unesco.org>/ |
| HDI | Share of seats in parliament (% held by women) | Inter-Parliamentary Union (IPU); https://data.ipu.org/ |
| 1.3.3 | Entrepreneurship environment |  |
| EIS | 1.3.2 Opportunity-driven entrepreneurship | Data source Global Entrepreneurship Monitor (GEM) |
| GII | 4.2.3 Venture capital deals/billion PPP$ GDP | Thomson Reuters, Thomson One Banker Private Equity database; International Monetary Fund, World Economic Outlook Database October 2016 (PPP$ GDP) (2015–16). (<https://www.thomsonone.com>; <https://www.imf.org/external/pubs/ft/weo/2016/02/weodata/index.aspx>) |
| EIS | 2.1.2 Venture capital expenditures | Data source VC data from Invest Europe. GDP data from Eurostat |
| GII | 6.2.2 New businesses/thousand pop. aged 15–64 | World Bank, Doing Business 2016, Entrepreneurship (2009–14). (<http://www.doingbusiness.org/data/exploretopics/entrepreneurship> ) |
| STIS | 73. Venture capital investment in selected countries, by sector, as a percentage of total venture capital investment | OECD, based on OECD Entrepreneurship Financing Database, September 2017 |
| AISR | Venture Capital Investment, million A$ | ABS (2016–2017) VC&LSPE, Australia, cat. No. 5678.0, 2014–15 to 2015–16, Ref: <http://www.abs.gov.au/ausstats/abs@.nsf/mf/5678.0>; |
| AISR | Entrepreneurial intentions, % | Global Entrepreneurship Research Association (GERA) (2017) Global Entrepreneurship Monitor (GEM), 2016–17, Adult Population Survey, URL: <http://www.gemconsortium.org/>; |
| AISR | Venture capital availability, score ranges from 1–7 (best) | WEF (2014–2017) Global Competitiveness Index, 2014–15 to 2017–18, URL: <http://www.weforum.org/>; |
| STIS, ISA 2016, AISR | Venture capital investments, % of GDP | OECD Entrepreneurship at a Glance, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/allprimarymainfeatures/BFFEF2819DF68CA2CA256B6B007AB94E?opendocument> |
| AISR | Early stage venture capital investment, % of GDP | OECD Entrepreneurship at a Glance |
| AISR | Later Stage Private Equity investment, % of GDP | OECD Entrepreneurship at a Glance |
| AISR | Barriers to entrepreneurship | OECD Entrepreneurship at a Glance |
| ISA 2016, ISA 2018, AISR | Total early-stage entrepreneurship activity, % | Global Entrepreneurship Monitor (GEM), <https://www.gemconsortium.org/data> |
| GCR | 9.03 Venture capital availability | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 11.05 Attitudes toward entrepreneurial risk | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 11.08 Companies embracing disruptive ideas | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 12.02 State of clusters development | WEF, Executive Opinion Survey. (see Note 2) |
| 1.4 | International environment |  |
| STIS | SMEs participating in international and public sector markets, by innovation status, 2012–14, as a percentage of businesses in the relevant category | OECD, based on the 2017 OECD survey of national innovation statistics and Eurostat Community Innovation Survey (CIS-2014), June 2017. <http://oe.cd/inno-stats>. |
| STIS | Jobs in the business sector sustained by foreign final demand, 2005 and 2014, as a percentage of total business sector employment | OECD calculations based on Inter-Country Input-Output (ICIO) Database, <http://oe.cd/icio> , Annual National Accounts Database, [www.oecd.org/std/na](http://www.oecd.org/std/na) , Structural Analysis (STAN) Database, <http://oe.cd/stan> ,Trade in Employment (TiM), <http://oe.cd/io-empn> ; World Input-Output Database (WIOD) and national sources, June 2017 |
| STIS | Share of compensation of employees in the business sector sustained by domestic and foreign final demand, 2014 | OECD calculations based on Inter-Country Input-Output (ICIO) Database, <http://oe.cd/icio> , Annual National Accounts Database, [www.oecd.org/std/na](http://www.oecd.org/std/na), Structural Analysis (STAN) Database, <http://oe.cd/stan> , Trade in Employment (TiM), <http://oe.cd/io-empn> and national sources, June 2017. |
| 1.4.1 | Trade and competition |  |
| GII | 4.3.2 Intensity of local competition | WEF, Executive Opinion Survey 2016–2017. (see Note 2) (<https://www.weforum.org/reports/the-global-competitiveness-report-2016-2017-1> ) |
| GCR | 7.08 Service trade openness | The World Bank Group. |
| GCR | 10.02 Imports of goods and services | World Trade Organization (WTO); International Monetary Fund (IMF). |
| PMR | Barriers to trade and investment | OECD Product Market Regulation database. |
| 1.4.1.1 | Free trade agreements |  |
| XXX | Nil at present | Nil |
| 1.4.1.2 | Tariff barriers |  |
| GII | 4.3.1 Applied tariff rate, weighted mean, %. | World Bank, based on data from United Nations Conference on Trade and Development’s Trade Analysis and Information System (TRAINS) database and the WTO’s Integrated Data Base (IDB) and Consolidated Tariff Schedules (CTS) database; extracted from World Bank World Development Indicators database (2011–15). (<http://data.worldbank.org/>) |
| GCR | 7.05 Trade tariffs | Source: International Trade Centre (ITC). |
| GCR | 7.06 Complexity of tariffs | Source: International Trade Centre (ITC). |
| 1.4.1.3 | Non-tariff barriers |  |
| GCR | 7.04 Prevalence of non-tariff barriers | WEF, Executive Opinion Survey. (see Note 2) |
| 2 | RESEARCH SYSTEM |  |
| 2.1 | R&D Funders |  |
| MSTI, ISA 2016, ISA 2018, AISR, GII, STIS | 2.3.2 Gross Expenditure on R&D (GERD), % of GDP | GII: UNESCO Institute for Statistics, UIS online database (2007–16). (<http://data.uis.unesco.org/>); OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| ABS, MSTI, AISR | Gross Expenditure on R&D (GERD), billion A$ | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Gross Domestic Expenditure on R&D -- GERD (million current PPP $) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | GERD per capita population (current PPP $) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Percentage of GERD financed by other national sources | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Percentage of BERD financed by other national sources | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| 2.1.1 | Government (funder) |  |
| MSTI | Government-financed GERD as a percentage of GDP | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Percentage of GERD financed by government | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI, AISR | Percentage of BERD financed by government | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI, STIS | Government Budget Allocations for R&D (GBARD) by socio-economic objectives: | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI, STIS | Total Government Budget Allocations for R&D -- GBARD (million current PPP $) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Total GBARD (million national currency for euro area: pre-EMU euro or EUR) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| SRIBT | Total Government investment in R&D (GBARD + GTARD) | SRI Budget Tables, <https://www.industry.gov.au/data-and-publications/science-research-and-innovation-sri-budget-tables> |
| AISR | Government Budget Appropriations or Outlays for R&D (GBAORD), % of GDP | OECD Main S&T Indicators |
| STIS | 70. Direct funding and tax incentive support for business R&D by SMEs, as a percentage of government support for BERD in each category | OECD, R&D Tax Incentive Indicators, <http://oe.cd/rdtax>, July 2017 |
| STIS | Direct government funding and tax support for business R&D, 2015, as a percentage of GDP | OECD, R&D Tax Incentive Indicators, <http://oe.cd/rdtax>, July 2017 |
| STIS | Change in government support for business R&D through direct funding and tax incentives, as a percentage of total support | OECD, R&D Tax Incentive Indicators, <http://oe.cd/rdtax>, July 2017 |
| STIS | Tax subsidy rates on R&D expenditures, 2017, 1-B-Index, by firm size and profit scenario | OECD, R&D Tax Incentive Indicators, <http://oe.cd/rdtax>, July 2017 |
| AISR | University income from Cooperative Research Centre (CRC) Research, million A$ | Australian Government (2013–2014) Higher Education Research Data Collection (HERDC), 2012–2013, URL: <http://education.gov.au/>; [5] Australian Government (2015–2017) Higher Education Research Data Collection (HERDC), 2014–2015–1, Research Block Grants, URL: <http://education.gov.au/> |
| AISR | Environmentally related government R&D budget, % of total government R&D | OECD (2016–2017) Green growth indicators, 2016–2 to 2017, URL: <http://www.oecd.org/> |
| 2.1.2 | Business (funder) |  |
| EIS | 3.2.3 Private co-funding of public R&D expenditures | Eurostat, <https://ec.europa.eu/eurostat/data/database> |
| GII | 5.1.4 GERD financed by business, % | UNESCO Institute for Statistics, UIS online database (2007–16). (<http://data.uis.unesco.org> ) |
| MSTI | Business-financed GERD as a percentage of GDP | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Percentage of GERD financed by the business enterprise sector | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI, AISR | Percentage of GOVERD financed by the business enterprise sector | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Business-financed BERD -- (million 2010 dollars -- constant prices and PPP) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Business-financed BERD as a percentage of value added in industry | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| STIS | Business R&D and government support for business R&D, by size, 2015, Share corresponding to SMEs, as a percentage of the relevant total | OECD, Research and Development Statistics Database, <http://oe.cd/rds>, June 2017 |
| STIS | R&D investment per patent of top corporate R&D investors, by headquarters’ location, 2012–14, Million USD per IP5 patent family | OECD calculations based on JRC-OECD, COR&DIP© Database v.1., June 2017 |
| STIS | Businesses receiving public support for innovation, by size, 2012–14, a percentage of product and/or process-innovating businesses in each size category | OECD, based on the 2017 OECD survey of national innovation statistics and Eurostat Community Innovation Survey (CIS-2014), June 2017. <http://oe.cd/inno-stats> |
| AISR | University income from industry and other funding sources, million A$ | Australian Government (2013–14) Higher Education Research Data Collection (HERDC), 2012–13, URL: <http://education.gov.au/>; [5] Australian Government (2015–17) Higher Education Research Data Collection (HERDC), 2014 – 2015–1, Research Block Grants, URL: <http://education.gov.au/> |
| ISA 2016, ISA 2018, AISR, MSTI | Percentage of HERD financed by industry | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) ABS 8111.0 – Research and Experimental Development, Higher Education Organisations, Australia <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8111.0> |
| 2.1.3 | Higher Education (funder) |  |
| STIS | Funding of R&D in higher education, as a percentage of Higher Education R&D expenditure | OECD, Research and Development Statistics Database, <http://oe.cd/rds>, June 2017 |
| 2.1.4 | Not-for-profit (funder) |  |
| MSTI | Percentage of Gross Expenditure on R&D (GERD) performed by the Private Non-Profit sector, % | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| 2.1.5 | Overseas (funder) |  |
| MSTI, AISR, GII | Percentage of GERD financed by the rest of the world | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ), UNESCO Institute for Statistics, UIS online database (2007–16). (<http://data.uis.unesco.org>) |
| MSTI, STIS, AISR | Business R&D funded from abroad, by source of funds, as a percentage of business enterprise expenditure on R&D | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>), OECD, Research and Development Statistics Database, <http://oe.cd/rds>, June 2017 |
| 2.2 | R&D Performers |  |
| MSTI | Gross Domestic Expenditure on R&D -- GERD (million current PPP $) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| AISR, MSTI, STIS, GCR, HDI | GERD as a percentage of GDP | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) ABS 8104.0 – Research and Experimental Development, Businesses, Australia, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/8104.0> ; World Bank (2018a) |
| MSTI | GERD per capita population (current PPP $) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | R&D expenditure of foreign affiliates (million current PPP $) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | R&D expenditure of foreign affiliates (million national currency – for euro area, pre-EMU euro or EUR) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | R&D expenditure of foreign affiliates as a percentage of R&D expenditure of enterprises | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| AISR | Gross Expenditure on R&D (GERD) per capita population, current PPP $ | OECD (2017) Main Science and Technology Indicators, 2016–2 to 2017, URL: <http://stats.oecd.org/>; |
| AISR | Public spending in environment-related R&D, % total public spending on R&D | OECD (2014) Green growth indicators, 2014, DOI: 10.1787/data-00686-en; |
| AISR | Energy public research, development and demonstration (RD&D) budget, % of GDP | OECD (2016–2017) Green growth indicators, 2016–2 to 2017, URL: <http://www.oecd.org/>; |
| AISR | Renewable energy public research, development and demonstration (RD&D) budget, % of total energy public RD&D | OECD (2016–2017) Green growth indicators, 2016–2 to 2017, URL: <http://www.oecd.org/>; |
| 2.2.1 | Government (Performer) |  |
| EIS | 2.1.1 R&D expenditure in the public sector | Data source Eurostat |
| MSTI | Percentage of GERD performed by the Government sector | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Government Intramural Expenditure on R&D -- GOVERD (million current PPP $) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | GOVERD (million national currency for euro area, pre-EMU euro or EUR) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | GOVERD (million 2010 dollars -- constant prices and PPP) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| ISA 2016, AISR, MSTI | Government expenditure on research and development (GOVERD), % of GDP | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>), 8109.0 – Research and Experimental Development, Government and Private Non-Profit Organisations, Australia, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/8109.0> |
| 2.2.2 | Business (Performer) |  |
| RDTI | Business expenditure on R&D by ANZSIC | R&D Tax Incentive program |
| EIS | 2.2.1 R&D expenditure in the business sector | Data source Eurostat |
| MSTI, ISA 2016, ISA 2018, AISR, STIS | Business expenditure on research and development (BERD), % of GDP | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>). ABS 8104.0 |
| ABS | Business expenditure on research and development (BERD) by Field of Research, Socio-Economic Objective, Type of Activity | 8104.0 – Research and Experimental Development, Businesses, Australia, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8104.0/> |
| ABS, MSTI, AISR | Business expenditure on R&D (BERD), billion A$ | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| GII | 2.3.3 Global R&D companies, avg. expend. top 3, million $US | EU JRC Industrial R&D Investment Scoreboard 2016. (<http://iri.jrc.ec.europa.eu/scoreboard16.html>) |
| GII | 5.1.3 GERD performed by business, % of GDP | UNESCO Institute for Statistics, UIS online database (2007–15). (<http://data.uis.unesco.org> ) |
| MSTI | Percentage of GERD performed by the Business Enterprise sector | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Business Enterprise Expenditure on R&D -- BERD (million current PPP $) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | BERD (million national currency for euro area, pre-EMU euro or EUR) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | BERD -- (million 2010 dollars -- constant prices and PPP) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | BERD as a percentage of value added in industry | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | BERD performed in the pharmaceutical industry (million current PPP $) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Percentage of BERD performed in the pharmaceutical industry | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | BERD performed in the computer, electronic and optical industry (million current PPP $) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Percentage of BERD performed in the computer, electronic and optical industry | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | BERD performed in the aerospace industry (million current PPP $) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Percentage of BERD performed in the aerospace industry | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | BERD performed in service industries (million current PPP $) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Percentage of BERD performed in service industries | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| STIS | Concentration of business R&D, as a percentage of domestic business R&D expenditure and of total count of performers, : top 50 and top 100 performers | OECD, based on preliminary results from the OECD microBeRD project, <http://oe.cd/microberd>, July 2017 |
| STIS | Business R&D performance by size and age, as a percentage of domestic business R&D expenditure | OECD, based on preliminary results from the OECD microBeRD project, <http://oe.cd/microberd>, July 2017. |
| STIS | R&D intensity by industry, 2015, as a percentage of gross value added, log scale | OECD calculations based on ANBERD, http://oe.cd/anberd, STAN, http://oe.cd/stan, National Accounts (SNA), and Research and Development Statistics (<http://oe.cd/rds>) Databases, June 2017. |
| STIS | New-to-market product innovators, by firm size, 2012–14, as a percentage of all businesses in each size category within the scope of national innovation surveys | OECD, based on the 2017 OECD survey of national innovation statistics and the Eurostat, Community Innovation Survey (CIS-2014), <http://oe.cd/inno-stats>, June 2017 |
| STIS | Business R&D intensity adjusted for industrial structure, 2015, as a percentage of value added in industry | OECD calculations based on the ANBERD Database, <http://oe.cd/anberd>, the National Accounts (SNA) Database, the Structural Analysis (STAN) Database, <http://oe.cd/stan>, Main Science and Technology Indicators Database, <http://oe.cd/msti>, and Research and Development Statistics Database, <http://oe.cd/rds>, June 2017. See chapter notes. |
| STIS | Business R&D expenditures by foreign-controlled affiliates, selected countries, 2015 or latest available, as a percentage of business enterprise expenditure on R&D | OECD, Activity of Multinational Enterprises Database, <http://oe.cd/amne>; Eurostat Inward FATS Database and Research and Development Statistics Database, <http://oe.cd/rds>, June 2017 |
| 2.2.3 | Higher Education (Performer) |  |
| MSTI | Percentage of GERD performed by the Higher Education sector | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI, ISA 2016, AISR, STIS | Higher education expenditure on research and development (HERD), % of GDP | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) 8111.0 – Research and Experimental Development, Higher Education Organisations, Australia, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/8111.0> |
| MSTI | Higher Education Expenditure on R&D -- HERD (million current PPP $) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | HERD (million 2010 dollars -- constant prices and PPP) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| NSRC | Research Expenditure | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| NSRC | Number of invention disclosures received | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| 2.2.4 | Not-for-profit (Performer) |  |
| MSTI | Percentage of GERD performed by the Private Non-Profit sector | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| 2.2.5 | Overseas (Performer) |  |
| MSTI | R&D expenditure of foreign affiliates (million current PPP $) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | R&D expenditure of foreign affiliates (million national currency for euro area, pre-EMU euro or EUR) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | R&D expenditure of foreign affiliates as a percentage of R&D expenditure of enterprises | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| 3 | NON-R&D BASED KNOWLEDGE AND IDEA CREATION |  |
| EIS | 2.2.2 Non-R&D innovation expenditures | Data source Eurostat (Community Innovation Survey) |
| GII | 7.2.1 Cultural & creative services exports, % of total trade | WTO, Trade in Commercial Services database, based on the sixth (2009) edition of the International Monetary Fund’s Balance of Payments Manual and Balance of Payments database; Bureau of Economic Analysis (BEA) released October 2016 (2007–15). (http://stat.wto.org/StatisticalProgram/WSDBStatProgramSeries.aspx; <http://www.oecd.org/std/its/EBOPS-2010.pdf> ; <https://www.bea.gov/iTable/iTable.cfm> ) |
| GII | 7.2.2 National feature films/million pop. aged 15–69 | UNESCO Institute for Statistics, UIS online database; United Nations, Department of Economic and Social Affairs, Population Division, World Population Prospects: The 2015 Revision (population) (2008–15). (http://data.uis.unesco.org; <http://esa.un.org/unpd/wpp/> ) |
| GII | 7.2.3 Global ent. & media market/thousand pop. aged 15–69 | The source of the data for the base of these calculations was derived from PwC’s Global Entertainment and Media Outlook, 2016–2020; United Nations, Department of Economic and Social Affairs, Population Division, World Population Prospects: The 2015 Revision (population); World Economic Outlook Database, October 2016 (current US$GDP); Middle East & North Africa in World Bank’s DataBank. (<http://www.pwc.com/outlook>; <http://esa.un.org/unpd/wpp/>; https://www.imf.org/external/pubs/ft/weo/2016/02/weodata/index.aspx; <http://data.worldbank.org/region/middle-east-and-north-africa>) |
| GII | 7.2.4 Printing & publishing manufactures, % | United Nations Industrial Development Organization, Industrial Statistics Database; 2-digit level of International Standard Industrial Classification ISIC Revision 3 (INDSTAT2 2015) (2006–14). (<http://www.unido.org/statistics.html>; <http://unstats.un.org/unsd/cr/registry/regcst.asp?cl=2> ) |
| GII | 7.2.5 Creative goods exports, % total trade | United Nations, COMTRADE database; 2009 UNESCO Framework for Cultural Statistics, Table 3, International trade of cultural goods and services based on the 2007 Harmonised System (HS 2007); WTO, Trade in Commercial Services database, itself based on the sixth (2009) edition of the International Monetary Fund’s Balance of Payments Manual and Balance of Payments database (2010–15). (<http://comtrade.un.org/>; <http://www.uis.unesco.org/culture/Documents/framework-cultural-statistics-culture-2009-en.pdf>; <http://stat.wto.org/StatisticalProgram/WSDBStatProgramSeries.aspx> ; <http://www.oecd.org/std/its/EBOPS-2010.pdf>) |
| GII | 7.3.3 Wikipedia edits/million pop. aged 15–69 | Wikimedia Foundation; United Nations, Department of Economic and Social Affairs, Population Division, World Population Prospects: The 2012 Revision (population). (<https://wikimediafoundation.org>; <https://esa.un.org/unpd/wpp/>) |
| GII | 7.3.4 Video uploads on YouTube/pop. aged15–69 | Google, parent company of YouTube; United Nations, Department of Economic and Social Affairs, Population Division, World Population Prospects: The 2012 Revision (population). (<http://www.youtube.com>; <http://esa.un.org/unpd/wpp/Excel-Data/population.htm>; <http://www.comscore.com/Industries/Media>) |
| 3.1 | Domestic |  |
| 3.1.1 | Domestic Government |  |
| XXX | Nil at present | Nil |
| 3.1.2 | Domestic Business |  |
| XXX | Nil at present | Nil |
| 3.2 | Overseas |  |
| 3.2.1 | Overseas Government |  |
| XXX | Nil at present | Nil |
| 3.2.2 | Overseas Business |  |
| XXX | Nil at present | Nil |
| 4 | HUMAN CAPITAL |  |
| 4.1 | Education and training |  |
| OECD | Total expenditure on educational institutions, % of GDP | OECD Education and Training Statistics, <https://www.oecd.org/statistics/data-collection/educationandtraining.htm> |
| GII, HDI | 2.1.1 Expenditure on education, % GDP | UNESCO Institute for Statistics, UIS online database (2007–16). (<http://data.uis.unesco.org/>) |
| OECD | Public expenditure on education, % of GDP | OECD Education and Training Statistics, <https://www.oecd.org/statistics/data-collection/educationandtraining.htm> |
| NCVER | Percentage of employers recruiting international students, % | National Centre for Vocational Education Research (NCVER), <https://www.ncver.edu.au/research-and-statistics/data/all-data> |
| NCVER | Employer difficulty sourcing/recruiting graduates, % | National Centre for Vocational Education Research (NCVER), <https://www.ncver.edu.au/research-and-statistics/data/all-data> |
| NCVER | Businesses reporting some or a lot of difficulty in recruiting staff, % of all employers | National Centre for Vocational Education Research (NCVER), <https://www.ncver.edu.au/research-and-statistics/data/all-data> |
| ABS | Barrier to innovation: Lack of skilled persons in any location, % of respondents | ABS 8158.0 – Innovation in Australian Business, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8158.0> |
| ISA 2018 | Percentage of population aged 25–64 with STEM at tertiary level, % | OECD Statistics: Education and training, Education at a glance: Educational attainment and labour-force status table <http://stats.oecd.org/>; Education at a Glance 2017: OECD indicators [https://www.hm.ee/sites/default/ files/eag2017\_eng.pdf](https://www.hm.ee/sites/default/%20files/eag2017_eng.pdf); ABS – Labour Force statistics |
| AISR, EIS | Proportion of population aged 25–34 with tertiary education, % | OECD Education and Training Statistics, <https://www.oecd.org/statistics/data-collection/educationandtraining.htm>; Eurostat, <https://ec.europa.eu/eurostat/data/database> |
| ISA 2016 | Population aged 25–64 with tertiary education, % | OECD Statistics: Education and Training, Education at a glance: *Table Educational attainment and labour-force status* <http://stats.oecd.org/>*;* Education at a Glance2017: OECD INDICATORS <https://www.hm.ee/sites/default/files/eag2017_eng.pdf> ABS 6202.0 – Labour Force, Australia <http://www.abs.gov.au/ausstats/abs@.nsf/mf/6202.0> |
| GII | 2.2.2 Graduates in science & engineering, % | UNESCO Institute for Statistics, UIS online database (2007–16). (<http://data.uis.unesco.org/> ) |
| ABS | % all graduates with a post-graduate degree | 6227.0 – Education and Work, Australia <http://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/6227.0> |
| STIS | 59. Women tertiary graduates in natural sciences, engineering and ICTs (NSE & ICT), As a percentage of all tertiary graduates in NSE & ICT | OECD calculations based on OECD, Education Database, September 2017. |
| AISR | Number of students completing higher degree by research in Australia⁵ ⁶ | National Centre for Vocational Education Research (NCVER), <https://www.ncver.edu.au/research-and-statistics/data/all-data> |
| AISR | Number of domestic students completing higher degree by research in Australia⁵ ⁶ | National Centre for Vocational Education Research (NCVER), <https://www.ncver.edu.au/research-and-statistics/data/all-data> |
| AISR | Number of international students completing higher degree by research in Australia⁵ ⁶ | National Centre for Vocational Education Research (NCVER), <https://www.ncver.edu.au/research-and-statistics/data/all-data> |
| STIS | Tertiary graduates in the natural sciences, engineering and ICTs (NSE & ICT), As a percentage of all tertiary graduates | OECD, based on OECD (2017), Education at a Glance 2017: OECD Indicators and OECD (2007), Education at a Glance 2007: OECD Indicators, OECD Publishing, Paris. |
| STIS | Tertiary graduates in Information and communication technologies, by gender, As a percentage of all tertiary graduates | OECD calculations based on OECD Education Database, September 2017. |
| STIS, ISA 2016 | Doctorate holders in the working age population, Per thousand population aged 25–64 | OECD calculations based on OECD data collection on Careers of Doctorate Holders 2017, <http://oe.cd/cdh>, OECD (2017), Education at a Glance 2017: OECD Indicators and OECD (2009), Education at a Glance 2009: OECD Indicators, OECD Publishing, Paris. |
| ISA 2016 | Population aged 25–64 with a doctorate per thousand population | OECD (2015) OECD Science, Technology and Industry Scoreboard 2015: Innovation for growth and society. OECD Publishing. Paris. pg. 102 OECD (2013) OECD Science, Technology and Industry Scoreboard 2013: Innovation for growth. OECD Publishing. Paris. pg. 96 ABS 6202.0 – Labour Force, Australia <http://www.abs.gov.au/ausstats/abs@.nsf/mf/6202.0> |
| STIS | R&D personnel, Per thousand employment | OECD, Main Science and Technology Indicators Database, <http://oe.cd/msti>, July 2017. |
| STIS | Researchers, by sector of employment, As a percentage of total researchers, full-time equivalents | OECD, Research and Development Statistics Database, http://oe.cd/rds, June 2017. |
| GII | 2.3.1 Researchers, FTE/million pop | UNESCO Institute for Statistics, UIS online database (2007–16). (<http://data.uis.unesco.org/> ) |
| GII | 5.1.1 Knowledge-intensive employment, % | International Labour Organization ILOSTAT Database of Labour Statistics (2007–15). (<http://www.ilo.org/ilostat/> ) |
| GII | 5.1.5 Females employed w/advanced degrees, % total | International Labour Organization, ILOSTAT Annual Indicators (2009–16); and Statistics Canada, Table 282-0004; Labour Force Survey estimates (LFS) by educational attainment, sex and age group, annual, CANSIM, accessed 9 February 2017. (<http://www.ilo.org/ilostat>/; <http://laborsta.ilo.org/> ; <http://www.statcan.gc.ca/> ) |
| MSTI | Total researchers (FTE) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Total researchers (FTE) per thousand total employment | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Total researchers (FTE) per thousand labour force | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Total R&D personnel (FTE) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Total R&D personnel (FTE) per thousand total employment | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Total R&D personnel (FTE) per thousand labour force | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Total researchers (headcount) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Women researchers (headcount) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Women researchers as a percentage of total researchers (based on headcount) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Government Sector: Total researchers (headcount) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Government Sector: Women researchers (headcount) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Government Sector: Women researchers as a percentage of total researchers (based on headcount) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Government researchers (FTE) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Government researchers (FTE) as a percentage of national total | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Government Total R&D personnel (FTE) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Higher Education sector: Total researchers (headcount) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Higher Education sector: Women researchers (headcount) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Higher Education sector: Women researchers as a percentage of total researchers (based on headcount) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Higher Education researchers (FTE) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Higher Education researchers (FTE) as a percentage of national total | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| MSTI | Higher Education Total R&D personnel (FTE) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm>) |
| STIS | 10.Researchers, per thousand employment by Gross domestic expenditures on R&D as a percentage of GDP | OECD, Main Science and Technology Indicators Database, <http://oe.cd/msti> and UNESCO Institute for Statistics, Research and experimental development (full dataset), July 2017. |
| STIS | International and domestic doctoral students in natural sciences, engineering and ICT (NSE & ICTs), 2015. | OECD calculations based on OECD Education Database, September 2017 |
| AISR | R&D personnel, % of total employment | OECD (2017) Main Science and Technology Indicators, 2016–2 to 2017, URL: <http://stats.oecd.org>/; |
| AISR | Researchers, % of total labour force | OECD (2017) Main Science and Technology Indicators, 2016–2 to 2017, URL: <http://stats.oecd.org>/; |
| AISR | Proportion of population aged 25–64 attaining upper secondary or post-secondary non-tertiary education, % | OECD Education and Training Statistics, <https://www.oecd.org/statistics/data-collection/educationandtraining.htm> |
| AISR | Proportion of population aged 25–64 attaining below upper secondary school education, % | OECD Education and Training Statistics, <https://www.oecd.org/statistics/data-collection/educationandtraining.htm> |
| AISR | PhD graduation rate | OECD Education and Training Statistics, <https://www.oecd.org/statistics/data-collection/educationandtraining.htm> |
| AISR | Lack of access to knowledge or technology, % of respondents (Barriers to innovation) | ABS 8158.0 – Innovation in Australian Business, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8158.0> |
| AISR | Lack of skilled persons in any location, % of respondents (Barriers to innovation) | ABS 8158.0 – Innovation in Australian Business, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8158.0> |
| AISR | Lack of skilled persons within the business, % of respondents (Barriers to innovation) | ABS 8158.0 – Innovation in Australian Business, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8158.0> |
| AISR | Lack of skilled persons within the labour market, % of respondents | ABS 8158.0 – Innovation in Australian Business, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8158.0> |
| NSRC | Number of academic researchers | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| NSRC | Number of research students | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| GCR | 6.05 Digital skills among active population | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 6.06 Ease of finding skilled employees | WEF, Executive Opinion Survey. (see Note 2) |
| GCR | 6.07 School life expectancy | UNESCO |
| OECD | Percentage of graduates in Science, Technology, Engineering and Mathematics programmes in tertiary education who are female | Education at a glance: [OECD.stat](https://stats.oecd.org/Index.aspx?DataSetCode=EDU_GRAD_FIELD) |
| 4.1.1 | Early childhood development |  |
| HDI | Gross enrolment ratio, pre-primary (% of preschool-age children) | UNESCO Institute for Statistics (2018), ICF Macro Demographic and Health Surveys, UNICEF Multiple Indicator Cluster Surveys and OECD (2017a).; http://data.uis.unesco.org/ |
| 4.1.2 | Schools |  |
| ISA 2018 | Programme for International Student Assessment (PISA) scores in science, reading, mathematics | OECD: PISA <http://www.oecd.org/Pisa/> |
| GII | 2.1.2 Gov’t expenditure/pupil, secondary, % GDP/cap | UNESCO Institute for Statistics, UIS online database (2007–16). (<http://data.uis.unesco.org/>) |
| GII | 2.1.3 School life expectancy, years | UNESCO Institute for Statistics, UIS online database (2007–16). (<http://data.uis.unesco.org/>) |
| GII | 2.1.4 PISA scales in reading, maths, & science | OECD Programme for International Student Assessment (PISA) (2010–15). ([www.pisa.oecd.org/](http://www.pisa.oecd.org/)) |
| GII | 2.1.5 Pupil-teacher ratio, secondary | UNESCO Institute for Statistics, UIS online database (2007–16). (<http://data.uis.unesco.org/>) |
| STIS | Top and low PISA performers in science and mathematics, As a percentage of 15 year-old students | OECD calculations based on OECD PISA 2015 Database, July 2017 |
| AISR | Expenditure on primary, secondary and post-secondary (non-tertiary educational) institutions, % of GDP | OECD Education and Training Statistics, <https://www.oecd.org/statistics/data-collection/educationandtraining.htm> |
| GCR, HDI | 6.01 Mean years of schooling | UNESCO; Wittgenstein Centre for Demography and Global Human Capital. |
| GCR | 6.09 Pupil-to-teacher ratio in primary education | The World Bank Group. |
| HDI | Gross enrolment ratio, secondary (% of secondary school-age population) | UNESCO Institute for Statistics (2018), ICF Macro Demographic and Health Surveys, UNICEF Multiple Indicator Cluster Surveys and OECD (2017a).; <http://data.uis.unesco.org/> |
| HDI | Gross enrolment ratio, primary (% of primary school-age population) | UNESCO Institute for Statistics (2018), ICF Macro Demographic and Health Surveys, UNICEF Multiple Indicator Cluster Surveys and OECD (2017a).; <http://data.uis.unesco.org/> |
| HDI | Expected years of schooling (years) | UNESCO Institute for Statistics (2018), ICF Macro Demographic and Health Surveys, UNICEF Multiple Indicator Cluster Surveys and OECD (2017a).; <http://data.uis.unesco.org/> |
| HDI | Expected years of schooling, female (years) | UNESCO Institute for Statistics (2018), ICF Macro Demographic and Health Surveys, UNICEF Multiple Indicator Cluster Surveys and OECD (2017a).; <http://data.uis.unesco.org/> |
| HDI | Expected years of schooling, male (years) | UNESCO Institute for Statistics (2018), ICF Macro Demographic and Health Surveys, UNICEF Multiple Indicator Cluster Surveys and OECD (2017a).; <http://data.uis.unesco.org/> |
| HDI | Mean years of schooling, female (years) | UNESCO Institute for Statistics (2018), ICF Macro Demographic and Health Surveys, UNICEF Multiple Indicator Cluster Surveys and OECD (2017a).; <http://data.uis.unesco.org/> |
| HDI | Mean years of schooling, male (years) | UNESCO Institute for Statistics (2018), ICF Macro Demographic and Health Surveys, UNICEF Multiple Indicator Cluster Surveys and OECD (2017a).; <http://data.uis.unesco.org/> |
| HDI | Population with at least some secondary education (% ages 25 and older) | UNESCO Institute for Statistics (2018), ICF Macro Demographic and Health Surveys, UNICEF Multiple Indicator Cluster Surveys and OECD (2017a).; <http://data.uis.unesco.org/> |
| HDI | Population with at least some secondary education, female (% ages 25 and older) | UNESCO Institute for Statistics (2018), ICF Macro Demographic and Health Surveys, UNICEF Multiple Indicator Cluster Surveys and OECD (2017a).; <http://data.uis.unesco.org/> |
| HDI | Population with at least some secondary education, male (% ages 25 and older) | UNESCO Institute for Statistics (2018), ICF Macro Demographic and Health Surveys, UNICEF Multiple Indicator Cluster Surveys and OECD (2017a).; <http://data.uis.unesco.org/> |
| HDI | Programme for International Student Assessment (PISA) score in mathematics | OECD (2017b).; <http://www.oecd.org/pisa/> |
| HDI | Programme for International Student Assessment (PISA) score in reading | OECD (2017b).; <http://www.oecd.org/pisa/> |
| HDI | Programme for International Student Assessment (PISA) score in science | OECD (2017b).; <http://www.oecd.org/pisa/> |
| 4.1.3 | VET |  |
| STIS | Expenditure on tertiary education and vocational programmes, As a percentage of GDP | OECD based on OECD (2017), Education at a Glance 2017: OECD Indicators, OECD Publishing, Paris |
| AISR | % of employers satisfied that vocational qualifications provide employees with the skills they require for the job. | National Centre for Vocational Education Research (NCVER), <https://www.ncver.edu.au/research-and-statistics/data/all-data> |
| AISR | % of employers satisfied that apprentices and trainees are obtaining skills they require from training | National Centre for Vocational Education Research (NCVER), <https://www.ncver.edu.au/research-and-statistics/data/all-data> |
| AISR | % of employers satisfied that nationally recognised training (which is not part of an apprenticeship or traineeship) provides employees with the skills they require for the job | National Centre for Vocational Education Research (NCVER), <https://www.ncver.edu.au/research-and-statistics/data/all-data> |
| AISR | Participation rate of Australians aged 15 years and older in VET, % | National Centre for Vocational Education Research (NCVER), <https://www.ncver.edu.au/research-and-statistics/data/all-data> |
| AISR | Number of qualifications completed by students in VET, '000s | National Centre for Vocational Education Research (NCVER), <https://www.ncver.edu.au/research-and-statistics/data/all-data> |
| AISR | Percentage of government-funded graduates employed in labour force after completing VET, % of respondents | National Centre for Vocational Education Research (NCVER), <https://www.ncver.edu.au/research-and-statistics/data/all-data> |
| AISR | Percentage of government-funded VET graduates satisfied with overall quality of training, % of respondents | National Centre for Vocational Education Research (NCVER), <https://www.ncver.edu.au/research-and-statistics/data/all-data> |
| AISR | Employer overall satisfaction with VET system, % | National Centre for Vocational Education Research (NCVER), <https://www.ncver.edu.au/research-and-statistics/data/all-data> |
| ISA 2018 | Vocational education and training completion rates | National Centre for Vocational Education Research (NCVER), <https://www.ncver.edu.au/research-and-statistics/data/all-data> |
| 4.1.4 | Higher Education (flow – production grads) |  |
| EIS | 1.1.1 New doctorate graduates | Eurostat, <https://ec.europa.eu/eurostat/data/database> |
| EIS | 1.1.3 Lifelong learning | Eurostat, <https://ec.europa.eu/eurostat/data/database> |
| EIS | 1.2.3 Foreign doctorate students | Eurostat, <https://ec.europa.eu/eurostat/data/database> |
| GII | 2.2.1 Tertiary enrolment, % gross | UNESCO Institute for Statistics, UIS online database (2007–16). (<http://data.uis.unesco.org/> ) |
| GII | 2.3.4 QS university ranking, average score top 3 | QS Quacquarelli Symonds Ltd, QS World University Ranking 2016/2017, Top Universities. (<https://www.topuniversities.com/university-rankings/world-university-rankings/2016>) |
| QILT | Measures of teaching quality | Quality Indicators of Learning and Teaching, Department of Education and Training/Social Research Centre, <https://www.qilt.edu.au/for-institutions/data-request> |
| QILT | Measures of learner engagement | Quality Indicators of Learning and Teaching, Department of Education and Training/Social Research Centre, <https://www.qilt.edu.au/for-institutions/data-request> |
| QILT | Measures of learning resources | Quality Indicators of Learning and Teaching, Department of Education and Training/Social Research Centre, <https://www.qilt.edu.au/for-institutions/data-request> |
| QILT | Measures of student support | Quality Indicators of Learning and Teaching, Department of Education and Training/Social Research Centre, <https://www.qilt.edu.au/for-institutions/data-request> |
| QILT | Measures of skills development | Quality Indicators of Learning and Teaching, Department of Education and Training/Social Research Centre, <https://www.qilt.edu.au/for-institutions/data-request> |
| QILT | Measures of employer satisfaction with graduate attributes | Quality Indicators of Learning and Teaching, Department of Education and Training/Social Research Centre, <https://www.qilt.edu.au/for-institutions/data-request> |
| AISR | Public expenditure on tertiary education, % of GDP | OECD Education and Training Statistics, <https://www.oecd.org/statistics/data-collection/educationandtraining.htm> |
| AISR | Proportion of international students enrolled in advanced research programs, % | OECD Education and Training Statistics, <https://www.oecd.org/statistics/data-collection/educationandtraining.htm> |
| ISA 2016, ISA 2018 | Academic Ranking of World Universities top 200 universities, per million population | ShanghaiRanking Consultancy (2016) Academic Ranking of World Universities 2016. Accessed at <http://www.shanghairanking.com/ARWU2016.html> OECD (2016) Main Science and Technology Indicators, 2016-1. Accessed at <https://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB> |
| ISA 2016 | Government and higher education researchers (full time equivalent) per thousand total employment | ABS 8111.0 – Research and Experimental Development, Higher Education Organisations, Australia <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8111.0> 8109.0 – Research and Experimental Development, Government and Private Non-Profit Organisations, Australia <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8109.0> |
| ISA 2016 | Universitas 21 national higher education systems ranking | Universitas 21 (2016) Data Comparison of the U21 Rankings. Accessed at <http://www.universitas21.com/rankingcomparison> |
| GCR | 12.08 Research institutions prominence index | SCImago; WEF. |
| HDI | Gross enrolment ratio, tertiary (% of tertiary school-age population) | UNESCO Institute for Statistics (2018), ICF Macro Demographic and Health Surveys, UNICEF Multiple Indicator Cluster Surveys and OECD (2017a).; <http://data.uis.unesco.org/> |
| 4.1.5 | Non-accredited education and training |  |
| XXX | Nil at present | Nil |
| 4.1.6 | On the job training and professional development) |  |
| EIS | 2.2.3 Enterprises providing training to develop or upgrade ICT skills of their personnel | Data source Eurostat, Community Survey of ICT Usage and E-commerce in Enterprises |
| GII | 5.1.2 Firms offering formal training, % firms | World Bank, Enterprise Surveys (2006–16). (<http://www.enterprisesurveys.org/> ). |
| AusTender | Income from education and training services provided by universities to government | Australian Government Department of Finance. <https://data.gov.au/dataset/historical-australian-government-contract-data> |
| STIS | 40. Workers receiving firm-based training, by skill level, As a percentage of total employed persons | OECD calculations based on the OECD Programme for International Assessment of Adult Competencies (PIAAC) Database, June 2017. |
| STIS | 43. Employees participating in on-the-job training, by gender, As a percentage of total employees of a given gender in the economy | OECD calculations based on the OECD Programme for International Assessment of Adult Competencies (PIAAC) Database, September 2017 |
| STIS | Workers receiving training, by type of training, As a percentage of total employed persons | OECD calculations based on the OECD Programme for International Assessment of Adult Competencies (PIAAC) Database, June 2017 |
| NSRC | Offering industry skills training to academic researchers or research students | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| NSRC | Total Number of partcipants that completed training in industry skills | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| 4.2 | Labour and skills mobility |  |
| STIS | 69. International net flows of scientific authors, Difference between annual fractional inflows and outflows, as a percentage of total flows | OECD calculations based on Scopus Custom Data, Elsevier, Version 4.2017, July 2017 |
| LinkedIn | Mobility of personnel between PFROs and industry | LinkedIn, <https://www.linkedin.com/feed/> |
| GCR | 8.08 Internal labour mobility | WEF, Executive Opinion Survey. (see Note 2) |
| 4.2.1 | Internships |  |
| XXX | Nil at present | Nil |
| 4.2.2 | Cross-sectoral staff placements and exchanges |  |
| XXX | Nil at present | Nil |
| 4.2.3 | Skilled migration |  |
| GII | 2.2.3 Tertiary inbound mobility, % | UNESCO Institute for Statistics, UIS online database (2007–16). (<http://data.uis.unesco.org/> ) |
| ABS | Skilled migration as a proportion of total (non-humanitarian) migration | ABS 3412.0 – Migration, Australia, <http://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/3412.0> |
| STIS | Internationally mobile students enrolled in tertiary education, 2015, Total and breakdown by field of education | OECD, based on OECD (2017), Education at a Glance 2017: OECD Indicators, OECD Publishing, Paris. |
| STIS | International mobility of scientific authors, 2016., As a percentage of authors, by last main recorded affiliation in 2016 | OECD calculations based on Scopus Custom Data, Elsevier, Version 4.2017, July 2017. |
| HDI | International student mobility (% of total tertiary enrolment) | UNESCO Institute for Statistics (2018). |
| 4.3 | * Entrepreneurship skills |  |
| Startup Muster | When Startup Was Founded Which Skills Were Strongly Represented In The Founding Team | Startup Muster survey, <https://www.startupmuster.com/reports> |
| 5 | DISTRIBUTION OF KNOWLEDGE |  |
| 5.1 | Publications |  |
| EIS | 3.2.2 Public-private co-publications | Data source Data provided by CWTS (Leiden University) as part of a contract to the European Commission (DG Research and Innovation) |
| EIS | 1.2.1 International scientific co-publications | Data source Data provided by CWTS (Leiden University) as part of a contract to the European Commission (DG Research and Innovation) |
| EIS | 1.2.2 Top 10% most cited publications as a percentage of total scientific publications of the country (field weighted) | Data source Data provided by CWTS (Leiden University) as part of a contract to the European Commission (DG Research and Innovation), OECD calculations based on Scopus Custom Data, Elsevier, Version 4.2017, July 2017 |
| GII | 6.1.4 Scientific & technical articles/billion PPP$ GDP | Clarivate Analytics, special tabulations from Thomson Reuters, Web of Science, Science Citation Index (SCI) and Social Sciences Citation Index (SSCI); International Monetary Fund, World Economic Outlook Database, October 2016 (PPP$ GDP) (2016). (<https://apps.webofknowledge.com> ; <https://www.imf.org/external/pubs/ft/weo/2016/02/weodata/index.aspx> ) |
| GII | 6.1.5 Citable documents H index | SCImago (2017) SJR–SCImago Journal & Country Rank. Retrieved February 2017. (<http://www.scimagojr.com> ) |
| STIS | 11. Percentage of the world’s top 10% most-cited publications | OECD calculations based on Scopus Custom Data, Elsevier, Version 4.2017, July 2017 |
| Leiden | Median number and proportion of university publications co-authored with one or more other organizations. | Leiden University Centre for Science and Technology Studies (CWTS), <http://www.journalindicators.com/indicators> |
| Leiden | Median number and proportion of university publications that have been co-authored by two or more countries. | Leiden University Centre for Science and Technology Studies (CWTS), <http://www.journalindicators.com/indicators> |
| Leiden | Median number and the proportion of university publications that have been co-authored with one or more industrial organizations. | Leiden University Centre for Science and Technology Studies (CWTS), <http://www.journalindicators.com/indicators> |
| STIS | 66. Open access of scientific documents, As a percentage of a random sample of 100 000 documents published in 2016 | OECD calculations based on Scopus Custom Data, Elsevier, Version 4.2017; and roaDOI “wrapper” routine for the oaDOI API, <https://oaDOI.org>, July 2017 |
| STIS | 67. Highly cited scientific documents, by open-access status, Percentage within the 10% most-cited published in 2016 | OECD calculations based on Scopus Custom Data, Elsevier, Version 4.2017; and roaDOI wrapper for the oaDOI API, <https://oaDOI.org>, July 2017 |
| STIS | 68. International collaboration in science and innovation, Co-authorship and co-invention as a percentage of scientific publications and IP5 patent families | OECD calculations based on Scopus Custom Data, Elsevier, Version 4.2017 and OECD, STI Micro-data Lab: IP Database, <http://oe.cd/ipstats>, July 2017. |
| STIS | Quantity and quality of scientific production, 2005 and 2015., Number of documents and percentage among the world’s 10% most cited publications, fractional counts | OECD calculations based on Scopus Custom Data, Elsevier, Version 4.2017; and 2015 Scimago Journal Rank from the Scopus journal title list (accessed June 2017), July 2017 |
| STIS | Specialisation and citation impact in science, selected fields, 2015, Percentage of documents in the top 10% ranked documents and relative specialisation, by field, fractional counts | OECD calculations based on Scopus Custom Data, Elsevier, Version 4.2017; and 2015 Scimago Journal Rank from the Scopus journal title list (accessed June 2017), July 2017 |
| STIS | International scientific collaboration, 2015, As a percentage of domestically authored documents, fractional counts | OECD calculations based on Scopus Custom Data, Elsevier, Version 4.2017, July 2017 |
| STIS | The citation impact of scientific production and the extent of international collaboration, 2012–16, Domestic and foreign-led top cited, as a percentage of all documents, fractional counts | OECD calculations based on Scopus Custom Data, Elsevier, Version 4.2017, July 2017. |
| STIS | Top 10% most-cited documents and patterns of international collaboration, 2015 | OECD calculations based on Scopus Custom Data, Elsevier, Version 4.2017; and 2015 Scimago Journal Rank from the Scopus journal title list (accessed June 2017), July 2017 |
| AISR | Share of world publications, % | InCites (2016–17) InCites, 2016 – 2017, Ref: Thomson Reuters subscription database |
| ISA 2016, ISA 2018 | Highly cited publications (top 1% or 10% in the world, all disciplines) per million population) | Thomson Reuters (2016) InCites. Accessed at [https://incites.thomsonreuters.com](https://incites.thomsonreuters.com/) OECD (2016) Main Science and Technology Indicators, 2016-1. Accessed at <https://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB> |
| GCR | 12.05 Scientific publications | SCImago. |
| 5.2 | * IP, licensing (out and in) and trade secrets |  |
| EIS | 3.3.1 PCT patent applications | Data source Patent data from the OECD. GDP data from Eurostat |
| EIS | 3.3.2 Trademark applications | Data source Trademark data from European Union Intellectual Property Office (EUIPO) and WIPO. GDP data from Eurostat |
| EIS | 3.3.3 Design applications | Data source Design data from European Union Intellectual Property Office (EUIPO). GDP data from Eurostat |
| GII | 5.2.5 Patent families 2+ offices/billion PPP$ GDP | WIPO, IP Statistics; International Monetary Fund, World Economic Outlook Database, October 2016 (PPP$ GDP) (2008–13). (<http://www.wipo.int//ipstats/> ; <https://www.imf.org/external/pubs/ft/weo/2016/02/weodata/index.aspx> ) |
| GII | 6.1.1 Patents by origin/billion PPP$ GDP | WIPO, IP Statistics; International Monetary Fund, World Economic Outlook Database, October 2016 (PPP$ GDP)(2010–15). (<http://www.wipo.int/ipstats/> ; <https://www.imf.org/external/pubs/ft/weo/2016/02/weodata/index.aspx> ) |
| GII | 6.1.2 PCT patent applications/billion PPP$ GDP | WIPO, IP Statistics; International Monetary Fund, World Economic Outlook Database, October 2016 (PPP$ GDP) (2010–15). (<http://www.wipo.int/ipstats/> ; <https://www.imf.org/external/pubs/ft/weo/2016/02/weodata/index.aspx> ) |
| GII | 7.1.1 Trademarks by origin/billion PPP$ GDP | WIPO, IP Statistics; International Monetary Fund, World Economic Outlook Database, October 2016 (PPP$ GDP) (2010–15). (<https://www.wipo.int/ipstats/en/>; <https://www.imf.org/external/pubs/ft/weo/2016/02/weodata/index.aspx> ) |
| GII | 7.1.2 Industrial designs by origin/billion PPP$ GDP | WIPO, IP Statistics; International Monetary Fund, World Economic Outlook Database, October 2016 (PPP$ GDP) (2010–15). (<http://www.wipo.int//ipstats/> ; <https://www.imf.org/external/pubs/ft/weo/2016/02/weodata/index.aspx> ) |
| MSTI | Number of triadic patent families (priority year) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Number of patent applications to the PCT (priority year) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Share of countries in triadic patent families (priority year) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Number of patent applications to the PCT in the ICT sector – (priority year) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Number of patent applications to the PCT in the biotechnology sector – (priority year) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| HEFP | Income to universities from royalties, trademarks and licenses | Department of Education and Training, Higher Education Finance Publication, <https://www.education.gov.au/finance-publication> |
| NSRC | Number of active LOA’s yielding income | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| NSRC | Total value of income yielded from active LOAs | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| NSRC | New PCT applications by universities as % of all patent applications by universities | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| STIS | 61. Patenting activity by women inventors, As a percentage of IP5 patent families by technology and inventors’ country | OECD, STI Micro-data Lab: IP Database, <http://oe.cd/ipstats>, June 2017 |
| STIS | International co-inventions in ICT, 2012–15., As a percentage of economies’ IP5 patent families | OECD, STI Micro-data Lab: IP Database, <http://oe.cd/ipstats>, June 2017 |
| STIS | Number of economies in which inventors are located, by technology, 2012–15 | OECD, STI Micro-data Lab: IP Database, <http://oe.cd/ipstats>, June 2017 |
| STIS | Domestic ownership of ICT inventions from abroad, 2012–15 | OECD, STI Micro-data Lab: IP Database, <http://oe.cd/ipstats>, June 2017 |
| AISR | Patent applications filed under PCT per million population | OECD (2017) Main Science and Technology Indicators, 2016–2 to 2017, URL: <http://stats.oecd.org/>; |
| AISR | Share of world triadic patent families | OECD (2017) Main Science and Technology Indicators, 2016–2 to 2017, URL: <http://stats.oecd.org/>; |
| AISR | Triadic patent families per million population | OECD (2017) Main Science and Technology Indicators, 2016–2 to 2017, URL: <http://stats.oecd.org/>; |
| AISR | Madrid system trademark registrations by country of origin | Cornell University, INSEAD, WIPO (2011–16) Global Innovation Index, GII 2011–16, URL: <http://www.globalinnovationindex.org> |
| AISR | Development of environment-related technologies, inventions per capita | OECD (2016–17) Green growth indicators, 2016-2 to 2017, URL: <http://www.oecd.org/>; |
| AISR | National office resident trademark registrations, per billion PPP$ GDP | Cornell University, INSEAD, WIPO (2011–16) Global Innovation Index, GII 201116, URL: <http://www.globalinnovationindex.org> |
| AISR | Patent Cooperation Treaty resident applications, per billion PPP$ GDP | Cornell University, INSEAD, WIPO (2011–16) Global Innovation Index, GII 2011–16, URL: <http://www.globalinnovationindex.org> |
| ISA 2016,ISA 2018 | Number of international patent applications filed by residents at the PCT per billion GDP (PPP) | Cornell, INSEAD and WIPO (2016) Global Innovation Index Analysis: 6.1.2 PCT international applications by origin. Accessed at <https://www.globalinnovationindex.org/analysis-indicator> |
| GCR | 12.06 Patent applications | Organisation for Economic Co-operation and Development (OECD). |
| GCR | 12.10 Trademark applications | WIPO. |
| 5.3 | Collaborations, contracts and consultancies between businesses and between businesses and research institutions |  |
| CRC | Investments made and income received by PFRO for mission-directed research | Cooperative Research Centre (CRC) program <https://www.business.gov.au/assistance/cooperative-research-centres-programme> |
| IC | Number of contracts and income received by PFROs for undertaking industry-focused research | Innovation Connections (IC) program (and precursors) <https://www.business.gov.au/assistance/entrepreneurs-programme/innovation-connections> |
| ARC | Investments made and income received by university for mission-directed research | ARC Linkage and Industrial Transformation Research Program <https://www.arc.gov.au/grants-and-funding/apply-funding/grants-dataset> |
| RRDC | Number of contracts, and income received by PFROs for undertaking agriculture-related research, by research focus | Rural R&D Corporations program data <http://www.agriculture.gov.au/ag-farm-food/innovation/research_and_development_corporations_and_companies> |
| SME Connect | Number of contracts and income received by PFROs for undertaking industry-focused research | CSIRO SME Connect <https://www.csiro.au/en/Do-business/Solutions-for-SMEs/About-SME-Connect> |
| GII | 5.2.1 University/industry research collaboration | WEF, Executive Opinion Survey 2016–17. (see Note 2) (<https://www.weforum.org/reports/the-global-competitiveness-report-2016-2017-1> ) |
| GII | 5.2.4 JV–strategic alliance deals/billion PPP$ GDP | Thomson Reuters, Thomson One Banker Private Equity, SDC Platinum database; International Monetary Fund World Economic Outlook Database, October 2016 (PPP$GDP) (2015–16). (<http://banker.thomsonib.com> ; <https://www.imf.org/external/pubs/ft/weo/2016/02/weodata/index.aspx> ) |
| NSRC | Gross contracted value of contracts, collaborations and consultancies for PFROs | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| HERDC | Research income to universities from contracts and consultancies | Department of Education and Training, Higher Education Research Data Collection, <https://www.education.gov.au/higher-education-research-data-collection> |
| STIS | Businesses collaborating on innovation with higher education or research institutions, by size, 2012–14 | OECD, based on the 2017 OECD survey of national innovation statistics and the Eurostat, Community Innovation Survey (CIS-2014), <http://oe.cd/inno-stats>, June 2017 |
| STIS | Businesses collaborating on innovation with suppliers and clients, by size, 2012–14, As percentage of product and/or process-innovating businesses in each size category | OECD, based on the 2017 OECD survey of national innovation statistics and the Eurostat, Community Innovation Survey (CIS-2014), <http://oe.cd/inno-stats>, June 2017 |
| STIS | Businesses engaged in international collaboration for innovation, by size,  2012–14, As a percentage of product and/or process-innovating businesses in each size category | OECD, based on the 2017 OECD survey of national innovation statistics and the Eurostat, Community Innovation Survey (CIS-2014), <http://oe.cd/inno-stats>, June 2017. |
| AISR | International collaboration in development of environment-related technologies, % collaboration in all technologies | OECD (2016) Green growth indicators, 2016–2, URL: <http://www.oecd.org/> |
| AISR | Percentage of innovation-active large firms collaborating with universities or other research institutions (excluding commercial), % | ABS (2012–15) Special request, 12-Oct-2012 to 2015–2; OECD (2013) Science, Technology and Industry Scoreboard, 2013, DOI: 10.1787/sti\_scoreboard-2013-en; OECD (2015) Science, Technology and Industry Scoreboard, 2015, DOI: 10.1787/20725345; |
| AISR | Percentage of innovation-active total businesses with international collaboration on innovation, % | ABS (2012–15) Special request, 12-Oct-2012 to 2015–2; OECD (2013) Science, Technology and Industry Scoreboard, 2013, DOI: 10.1787/sti\_scoreboard-2013-en; |
| AISR | Percentage of innovation-active total businesses collaborating with universities or other research institutions excluding commercial, as a percentage of collaborative innovation-active businesses, % | ABS (2012–15) Special request, 12-Oct-2012 to 2015–2; |
| AISR, STIS | Percentage of innovation-active total businesses collaborating on innovation, % | ABS Selected Characteristics of Australian Business, cat. no. 8167.0, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8167.0> |
| AISR, STIS | Proportion of non-innovation active businesses collaborating for any reason, % of respondents | ABS Selected Characteristics of Australian Business, cat. no. 8167.0, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8167.0> |
| AISR, STIS | Proportion of innovation-active businesses collaborating for any reason, % of respondents | ABS Selected Characteristics of Australian Business, cat. no. 8167.0, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8167.0> |
| AISR, STIS | Percentage of innovation-active SMEs collaborating on innovation, % | ABS 8158.0 – Innovation in Australian Business, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8158.0>, Special request |
| AISR, STIS | Percentage of innovation-active large firms collaborating on innovation, % | ABS 8158.0 – Innovation in Australian Business, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8158.0>, Special request |
| AISR | Percentage of innovation-active SMEs that collaborate with non-commercial research institutions, as a percentage of collaborative innovation-active businesses, % | ABS 8158.0 – Innovation in Australian Business, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8158.0>, Special request |
| AISR | Percentage of innovation-active SMEs collaborating with universities or other research institutions (excluding commercial) | ABS 8158.0 – Innovation in Australian Business, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8158.0>, Special request |
| AISR | Percentage of innovation-active large firms that collaborate with non-commercial research institutions, as a percentage of collaborative innovation-active businesses, % | ABS 8158.0 – Innovation in Australian Business, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8158.0>, Special request |
| ISA 2016 | Proportion of publications with industry affiliated co-authors, % | Thomson Reuters (2016) InCites. Accessed at <https://incites.thomsonreuters.com/#/analytics> |
| ISA 2016, ISA 2018 | Proportion of Patent Cooperation Treaty (PCT) Australian patents with foreign co-inventors, % | OECD (2016) International co-operation in patents: patent applications filed under the PCT with foreign co inventors. Accessed at <http://stats.oecd.org/Index.aspx?DatasetCode=PATS_COOP> |
| GCR | 12.03 International co-inventions | Organisation for Economic Co-operation and Development (OECD). |
| GCR | 12.04 Multistakeholder collaboration | WEF, Executive Opinion Survey. (see Note 2) |
| 5.4 | PFRO facilities, technology, materials, processes |  |
| NSRC | Material Transfer Agreements, number and value of | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| NSRC | Expenditure on research commercialisation staff and FTE staff numbers | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| AISR | Diffusion of environment-related technologies, % all technologies | OECD (2016–17) Green growth indicators, 2016-2 to 2017, URL: <http://www.oecd.org/>; |
| 5.5 | Networks |  |
| GII | 5.2.2 State of cluster development | WEF, Executive Opinion Survey 2016–17. (<https://www.weforum.org/reports/the-global-competitiveness-report-2016-2017-1> ) |
| 6 | APPLICATION CAPABILITIES |  |
| EP | Number of firms, by ANZSIC, receiving various kinds of business support | Entrepreneurs’ Programme |
| EIS | 3.1.1 SMEs with product or process innovations | Data source Eurostat (Community Innovation Survey) |
| EIS | 3.1.2 SMEs with marketing or organisational innovations | Data source Eurostat (Community Innovation Survey) |
| EIS | 3.1.3 SMEs innovating in-house | Data source Eurostat (Community Innovation Survey) |
| EIS | 3.2.1 Innovative SMEs collaborating with others | Data source Eurostat (Community Innovation Survey) |
| AISR, STIS | Percentage of innovation-active firms, % | ABS 8166.0 Summary of IT use and Innovation, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/8166.0> |
| AISR, STIS | Percentage of innovation-active large firms, % | ABS 8166.0 Summary of IT use and Innovation, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/8166.0> |
| AISR, STIS | Proportion of businesses introducing goods or services innovation, % | ABS 8166.0 Summary of IT use and Innovation, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/8166.0> |
| AISR, STIS | Proportion of businesses introducing operational/ process innovation, % | ABS 8166.0 Summary of IT use and Innovation, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/8166.0> |
| AISR, STIS | Proportion of businesses introducing organisational/managerial process innovation, % | ABS 8166.0 Summary of IT use and Innovation, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/8166.0> |
| AISR, STIS | Proportion of businesses introducing marketing innovation, % | ABS 8166.0 Summary of IT use and Innovation, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/8166.0> |
| AISR | Development of environment-related technologies, % all technologies | OECD (2016–17) Green growth indicators, 2016–2 to 2017, URL: <http://www.oecd.org/>; |
| ISA 2016 | Percentage of firms that introduced new-to-market product innovation | OECD (2015) OECD Innovation Indicators 2015: June 2015. Accessed from <http://www.oecd.org/sti/inno-stats.htm> OECD (2013) OECD Innovation Indicators 2013: June 2013, Accessed from <http://www.oecd.org/sti/inno-stats.htm> |
| ABS | Written strategic plan or policy in place, all businesses, % | [ABS Cat. 8172.0](http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8172.02015-16?OpenDocument) |
| 6.1 | Absorptive capacity |  |
| XXX | Nil at present | Nil |
| 6.2 | Management capability |  |
| GCR | 11.06 Willingness to delegate authority | WEF, Executive Opinion Survey. (see Note 2) |
| 6.3 | Innovation capability |  |
| 6.3.1 | R&D capacity |  |
| XXX | Nil at present | Nil |
| 6.3.2 | Design capability |  |
| XXX | Nil at present | Nil |
| 6.3.3 | Workforce skills and HR |  |
| SEEK | Demand for PhD skills by industry sector and location | SEEK dataset, interpreted using methodology developed by the ANU and Data61 |
| GII | 5.3.5 Research talent, % in business enterprise | UNESCO Institute for Statistics, UIS online database (2007–16). (<http://data.uis.unesco.org> ) |
| ISA 2016, MSTI | Business researchers, per thousand employed in industry | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Business Enterprise Sector: Total researchers (headcount) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Business Enterprise Sector: Women researchers (headcount) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Business Enterprise Sector: Women researchers as a percentage of total researchers (based on headcount) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Business Enterprise researchers (FTE) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Business Enterprise researchers (FTE) as a percentage of national total | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Business Enterprise researchers (FTE) per thousand employment in industry | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Total Business Enterprise R&D personnel (FTE) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Total Business Enterprise R&D personnel (FTE) as a percentage of national total | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Total Business Enterprise R&D personnel (FTE) per thousand employment in industry | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| STIS | Business investment in fixed and knowledge-based capital, As a percentage of business sector gross value added | OECD calculations based on the OECD System of National Accounts (SNA) Database, INTAN-Invest data (<http://www.intan-invest.net>); and U.S. Bureau of Economic Analysis data, May 2017. |
| STIS | Market and non-market sector KBC investment, selected economies, As a percentage of gross value added in the sector | OECD calculations based on the OECD System of National Accounts (SNA) Database, INTAN-Invest data, (<http://www.intan-invest.net>), and SPINTAN data (<http://www.spintan.net>), May 2017 |
| HDI | Skilled labour force (% of labour force) | ILO (2018a).; <https://www.ilo.org/ilostat/faces/oracle/webcenter/portalapp/pagehierarchy/Page27.jspx?subject=SDG&indicator=SDG_0552_OCU_RT&datasetCode=A&collectionCode=SDG>; Labor Force Survey |
| 6.3.4 | Digital capability |  |
| GII | 6.2.3 Computer software spending, % GDP | IHS Global Insight, Information and Communication Technology Database. (<https://www.ihs.com/index.html> ) |
| STIS | 28. Industrial robot stock over manufacturing value added, millions USD, current values | OECD calculations based on International Federation of Robotics data, and the World Bank, Word Development Indicators Database, September 2017. StatLink contains more data |
| STIS | 29. Robot intensity and ICT task intensity of manufacturing jobs, Correlation of robots per worker and average ICT task intensity | OECD calculations based on OECD Programme for International Assessment of Adult Competencies (PIAAC) Database and International Federation of Robotics, September 2017 |
| AISR | Firm-level technology absorption, score ranges from 1–7 (best) | WEF (2014–17) Global Competitiveness Index, 2014–15 to 2017–18, URL: <http://www.weforum.org/>; |
| 6.3.5 | IP management and appropriation |  |
| NSRC | IPR protection external fees and legal costs | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| 6.3.6 | Supply-chain integration |  |
| XXX | Nil at present | Nil |
| 6.4 | Financial capability |  |
| XXX | Nil at present | Nil |
| 6.4.1 | Investment (debt or equity) |  |
| XXX | Nil at present | Nil |
| 7 | APPLICATION PERFORMANCE |  |
| ARTG | Proportion of Australian sponsors or manufacturers of registered therapeutic goods | Australian Register of Therapeutic Goods (ARTG), <https://www.tga.gov.au/artg> |
| AISR | Adjusted gross income from Licenses, Options and Assignments by major publicly funded research agencies, universities and medical research institutes million A$ | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| AISR | Number of Licenses, Options and Assignments yielding income from major publicly funded research agencies, universities and medical research institutes | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| AISR | Number of patents granted worldwide from publicly funded research agencies, universities, and medical research institutes (MRIs) | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| AISR | Value of equity holdings by major publicly funded research agencies, universities and medical research institutes, million A$ | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| AISR | Number of start-up companies in which major publicly funded research agencies, universities and medical research institutes have an equity holding | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| 7.1 | New products and processes |  |
| STIS | Innovation types, by business size,  2012–14, as a percentage of all businesses in each size category within the scope of national innovation surveys | OECD, based on the 2017 OECD survey of national innovation statistics and the Eurostat, Community Innovation Survey (CIS-2014), <http://oe.cd/inno-stats>, June 2017 |
| 7.2 | Start-ups and spinouts |  |
| NSRC | Median value of research commercialisation equity holdings | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| NSRC | No start-ups dependent upon licensing/ assignment for initiation | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| NSRC | No of start-ups dependent upon licensing/ assignment for initiation institution held equity | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| NSRC | Number of start-up companies created | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| NSRC | Number of patent families represented in new patent applications worldwide (NUM\_FAMS) in PFRO start-ups/spinouts | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| NSRC | Number of patents granted to an institution elsewhere (NUM\_GRANTS\_ELSE) in PFRO start-ups/spinouts | National Survey of Research Commercialisation (NSRC), <https://www.industry.gov.au/data-and-publications/national-survey-of-research-commercialisation-nsrc> |
| 8 | IMPACTS |  |
| 8.1 | Economic |  |
| AISR | Rate of high-growth enterprises, measured by employment growth, % | ABS (special request) |
| AISR | Rate of high-growth enterprises in the construction sector, measured by employment growth | ABS (special request) |
| AISR | Rate of high-growth enterprises in the industry sector, measured by employment growth, % | ABS (special request) |
| AISR | Rate of high-growth enterprises in the services sector, measured by employment growth, % | ABS (special request) |
| AISR | Rate of high-growth enterprises, measured by turnover growth, % | ABS (special request) |
| AISR | Rate of high-growth enterprises in the construction sector, measured by turnover growth, % | ABS (special request) |
| AISR | Rate of high-growth enterprises in the industry sector, measured by turnover growth, % | ABS (special request) |
| AISR | Rate of high-growth enterprises in the services sector, measured by turnover growth, % | ABS (special request) |
| ISA 2016, ISA 2018 | High growth enterprise rate, measured by employment growth, industry, % | OECD Statistics, SDBS Business Demography Indicators (ISIC REV.4): Rate of high-growth enterprise. Data on HE\_R-Rate of high-growth enterprises (20% growth based on employment: <<https://stats.oecd.org/>> ABS 2017: Business longitudinal analysis data environment (BLADE); Customised data analysis commissioned by the Department of Industry, Innovation and Science. |
| ABS | Percentage of income from sales due to innovation in goods or services | ABS 8158.0 – Innovation in Australian Business <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8158.0> |
| ABS | Percentage of innovation-active businesses that have increased revenue as result of innovation | ABS 8158.0 – Innovation in Australian Business <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8158.0> |
| ABS | Percentage of innovation-active businesses that have reduced costs as result of innovation | ABS 8158.0 – Innovation in Australian Business <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8158.0> |
| ABS | Percentage of innovation-active businesses that have gained a competitive edge as a result of innovation | ABS 8158.0 – Innovation in Australian Business <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8158.0> |
| ABS | Percentage of innovation-active businesses that have improved customer service as a result of innovation | ABS 8158.0 – Innovation in Australian Business <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8158.0> |
| 8.1.1 | National economic performance |  |
| EIS | 4.2.3 Sales of new-to-market and new-to-firm product innovations | Data source Eurostat (Community Innovation Survey) |
| GII, GCR | 4.2.2 Market capitalization, % GDP. 9.04 Market capitalization | World Federation of Exchanges database; extracted from the World Bank’s World Development Indicators database (2008–15). (<http://data.worldbank.org/>) |
| AISR | Market capitalization of listed companies, % of GDP | World Bank Statistics – WB\_WDI <https://data.worldbank.org/> |
| AISR | Contribution to employment, income, exports and VA, of business by degree of novelty (time series) as per Fig 2.1 AISR 2016. | ABS (special request) |
| AISR | Proportion of high-growth firms (by turnover, by employment) that are innovation-active, definitions to be confirmed. | ABS (special request) |
| AISR | Percentage of innovation-active SME firms, % | OECD STI Scoreboard (pre-2017) |
| HDI | Income quintile ratio, average annual change (%) | World Bank (2018a) |
| HDI | Total debt service (% of exports of goods, services and primary income) | World Bank (2018a) |
| OECD | Household net adjusted disposable income | [OECD Better Life Index 2017](https://stats.oecd.org/Index.aspx?DataSetCode=BLI) |
| 8.1.1.1 | Employment |  |
| EIS | 4.1.1 Employment in knowledge-intensive activities | Data source Eurostat |
| EIS | 4.1.2 Employment fast-growing enterprises of innovative sectors | Data source Eurostat |
| HDI | Unemployment, total (% of labour force) | ILO (2018a).; <https://www.ilo.org/ilostat/faces/oracle/webcenter/portalapp/pagehierarchy/Page27.jspx?subject=SDG&indicator=SDG_0552_OCU_RT&datasetCode=A&collectionCode=SDG>; Labor Force Survey |
| HDI | Unemployment, youth (% ages 15–24) | ILO (2018a).; <https://www.ilo.org/ilostat/faces/oracle/webcenter/portalapp/pagehierarchy/Page27.jspx?subject=SDG&indicator=SDG_0552_OCU_RT&datasetCode=A&collectionCode=SDG>; Labor Force Survey |
| HDI | Vulnerable employment (% of total employment) | ILO (2018a).; <https://www.ilo.org/ilostat/faces/oracle/webcenter/portalapp/pagehierarchy/Page27.jspx?subject=SDG&indicator=SDG_0552_OCU_RT&datasetCode=A&collectionCode=SDG>; Labor Force Survey |
| HDI | Youth not in school or employment (% ages 15–24) |  |
| 8.1.1.2 | Workforce composition |  |
| STIS | 34.Relative contribution to change in total employment by major sectors of economic activity | OECD calculations based on Annual National Accounts Database, www.oecd.org/std/na, Structural Analysis (STAN) Database, http://oe.cd/stan and national sources, September 2017 |
| ABS | Contribution to employment (% of employment and numbers of FTE) of innovation-active start-ups (0–2 years), ABS Special request, build time series and provide sectoral disaggregation. | ABS Special request, BLADE |
| STIS | Highly educated individuals in the working-age population, by place of birth, 2015., As a percentage of relevant group, 15–64 year-old population | OECD calculations based on Eurostat Labour Force Survey and national sources, July 2017. |
| AISR | Share of professionals and technicians in total employment, % | OECD STI Scoreboard 2007, 2009, 2011, 2013 |
| HDI | Employment to population ratio (% ages 15 and older) | ILO (2018a).; <https://www.ilo.org/ilostat/faces/oracle/webcenter/portalapp/pagehierarchy/Page27.jspx?subject=SDG&indicator=SDG_0552_OCU_RT&datasetCode=A&collectionCode=SDG>; Labor Force Survey |
| HDI | Employment in agriculture (% of total employment) | ILO (2018a).; <https://www.ilo.org/ilostat/faces/oracle/webcenter/portalapp/pagehierarchy/Page27.jspx?subject=SDG&indicator=SDG_0552_OCU_RT&datasetCode=A&collectionCode=SDG>; Labor Force Survey |
| HDI | Employment in services (% of total employment) | ILO (2018a).; <https://www.ilo.org/ilostat/faces/oracle/webcenter/portalapp/pagehierarchy/Page27.jspx?subject=SDG&indicator=SDG_0552_OCU_RT&datasetCode=A&collectionCode=SDG>; Labor Force Survey |
| HDI | Labour force participation rate (% ages 15 and older) | ILO (2018a).; <https://www.ilo.org/ilostat/faces/oracle/webcenter/portalapp/pagehierarchy/Page27.jspx?subject=SDG&indicator=SDG_0552_OCU_RT&datasetCode=A&collectionCode=SDG>; Labor Force Survey |
| HDI | Labour force participation rate (% ages 15 and older), female | ILO (2018a).; <https://www.ilo.org/ilostat/faces/oracle/webcenter/portalapp/pagehierarchy/Page27.jspx?subject=SDG&indicator=SDG_0552_OCU_RT&datasetCode=A&collectionCode=SDG>; Labor Force Survey |
| HDI | Labour force participation rate (% ages 15 and older), male | ILO (2018a).; <https://www.ilo.org/ilostat/faces/oracle/webcenter/portalapp/pagehierarchy/Page27.jspx?subject=SDG&indicator=SDG_0552_OCU_RT&datasetCode=A&collectionCode=SDG>; Labor Force Survey |
| 8.1.1.3 | Productivity & efficiency |  |
| GII | 6.2.1 Growth rate of PPP$ GDP/worker, % | The Conference Board Total Economy Database™ Output, Labor and Labor Productivity, 1950–2016, May 2016. (<https://www.conference-board.org/data/economydatabase/>) |
| STIS | 46. Multifactor productivity growth, Total economy, percentage change at an annual rate | OECD calculations based on OECD Productivity Database, <http://www.oecd.org/sdd/productivity-stats/>, September 2017. |
| AISR | Multifactor productivity annual growth/change, % | OECD Productivity Statistics, <http://www.oecd.org/sdd/productivity-stats/> |
| ISA 2016, ISA 2018 | Multifactor productivity change, five year compound annual growth rate, % | OECD Productivity Statistics, <http://www.oecd.org/sdd/productivity-stats/> |
| 8.1.2 | International performance |  |
| HDI | Exports and imports (% of GDP) | World Bank (2018a). |
| World Bank | Export of goods and services (% of GDP) | [World Bank](https://data.worldbank.org/indicator/NE.EXP.GNFS.ZS?locations=AU) |
| 8.1.2.1 | Exports |  |
| EIS | 4.2.1 Medium and high-tech product exports | Data source Eurostat (ComExt) for Member States, UN ComTrade for non-EU countries |
| EIS | 4.2.2 Knowledge-intensive services exports | Data source Eurostat |
| GII | 6.3.1 Intellectual property receipts, % total trade | WTO, Trade in Commercial Services database, based on the sixth (2009) edition of the International Monetary Fund’s Balance of Payments Manual and Balance of Payments database (2007–15). (<http://stat.wto.org/StatisticalProgram/WSDBStatProgramSeries.aspx> ; <http://www.oecd.org/std/its/EBOPS-2010.pdf> ) |
| MSTI | Export market share: Pharmaceutical industry | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Total imports: Pharmaceutical industry (million current dollars) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Total exports: Pharmaceutical industry (million current dollars) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Trade Balance: Pharmaceutical industry (million current dollars) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Export market share: Computer, electronic and optical industry | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Total imports: Computer, electronic and optical industry (million current dollars) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Total exports: Computer, electronic and optical industry (million current dollars) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Trade Balance: Computer, electronic and optical industry (million current dollars) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Export market share: Aerospace industry | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Total imports: Aerospace industry (million current dollars) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Total exports: Aerospace industry (million current dollars) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Trade Balance: Aerospace industry (million current dollars) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Export market share: Pharmaceutical industry | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Technology balance of payments: Receipts (million current dollars) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Technology balance of payments: Receipts (million national currency for euro area, pre-EMU euro or EUR) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Technology balance of payments: Payments (million current dollars) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Technology balance of payments: Payments (million national currency for euro area, pre-EMU euro or EUR) | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| MSTI | Technology balance of payments: Payments as a percentage of GERD | OECD Main Science and Technology Indicators. (<http://www.oecd.org/sti/msti.htm>; <http://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm> ) |
| GII | 6.3.2 High-tech exports less re-exports, % total trade | United Nations, COMTRADE database; Eurostat, Annex 5: High-tech aggregation by SITC Rev. 4, April 2009 (2010–15). (<http://comtrade.un.org/>; <http://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an5.pdf> ) |
| GII | 6.3.3 ICT services exports, % total trade | WTO, Trade in Commercial Services database, based on the sixth (2009) edition of the International Monetary Fund’s Balance of Payments Manual and Balance of Payments database (2009–15). |
| GII | 6.3.4 FDI net outflows, % GDP | International Monetary Fund, Balance of Payments database, supplemented by data from the United Nations Conference on Trade and Development and official national sources; extracted from the World Bank’s World Development Indicators database (2013–15). (<http://data.worldbank.org/> ) |
| STIS | 47. Extended ICT domestic value added footprint, USD billions and world share, percent | OECD, Inter-Country Input-Output (ICIO) Database, <http://oe.cd/icio>, and Trade in Value Added (TiVA) database, <http://oe.cd/tiva>, July 2017 |
| STIS | 48. ICT-related domestic value added, As a percentage of GDP | OECD, Inter-Country Input-Output (ICIO) Database, <http://oe.cd/icio>, and Trade in Value Added (TiVA) database, <http://oe.cd/tiva>, July 2017. |
| STIS | Regional origin of foreign value added embodied in gross exports, 2014, As a percentage of domestic gross export | OECD estimates based on Trade in Value Added (TiVA) Database, <http://oe.cd/tiva>, Inter-Country Input-Output (ICIO) Database, <http://oe.cd/icio>, Bilateral Trade Database by Industry and End-use (BTDIxE), <http://oe.cd/btd>, Annual National Accounts Database, [www.oecd.org/std/na](http://www.oecd.org/std/na), and most recent national Supply and use Tables and Input Output Tables, April 2017. |
| STIS | Domestic value added embodied in partner countries’ exports, 2014, As a percentage of domestic gross exports | OECD estimates based on Trade in Value Added (TiVA) Database, <http://oe.cd/tiva>, Inter-Country Input-Output (ICIO) Database, <http://oe.cd/icio>, Bilateral Trade Database by Industry and End-use (BTDIxE), <http://oe.cd/btd>, Annual National Accounts Database, [www.oecd.org/std/na](http://www.oecd.org/std/na), and most recent national Supply and use Tables and Input Output Tables, April 2017 |
| AISR | Exports of goods, % of GDP | OECD National Accounts |
| AISR | Exports of services, % of GDP | OECD National Accounts |
| AISR | Exports in raw commodities, % of GDP | OECD National Accounts |
| AISR | Trade, % of GDP | World Bank statistics |
| STIS | Sectoral origin of the domestic value added created by gross exports, 2014 | OECD estimates based on Trade in Value Added (TiVA) Database, <http://oe.cd/tiva>, Inter-Country Input-Output (ICIO) Database, <http://oe.cd/icio>, Bilateral Trade Database by Industry and End-use (BTDIxE), <http://oe.cd/btd>, Annual National Accounts Database, [www.oecd.org/std/na](http://www.oecd.org/std/na), and most recent national Supply and use Tables and Input Output Tables, April 2017 |
| AISR | Intellectual property balance of payments, million A$ | ABS (2014) International Trade in Services by Country, by state and by Detailed Services Category, Calendar Year, cat. no. 5368.0.55.004, 2013, International Trade in Services, Debits, Calendar Year by Country & Service, URL: <http://www.abs.gov.au/>; ABS (2014–15) International Trade in Services by Country, by state and by Detailed Services Category, Calendar Year, cat. no. 5368.0.55.004, 2013–14, International Trade in Services, Credits, Calendar Year by Country & Service, URL: <http://www.abs.gov.au/>; ABS (2017) International Trade in Services by Country, by state and by Detailed Services Category, Calendar Year, cat. no. 5368.0.55.004, 2016, Table 5.8 International Trade in Services, Credits, Calendar Year by Country & Service, $m – Charges for the use of IP, URL: <http://www.abs.gov.au/>; ABS (2017) International Trade in Services by Country, by state and by Detailed Services Category, Calendar Year, cat. no. 5368.0.55.004, 2016, Table 6.8 International Trade in Services, Debits, Calendar Year by Country & Service, URL: <http://www.abs.gov.au/>; |
| AISR, MSTI | Technology balance of payments (receipts minus payments), % of GDP | OECD (2017) Main Science and Technology Indicators, 2016–2 to 2017, URL: <http://stats.oecd.org/>; |
| AISR | Share of international tertiary education market, % | OECD Education at a glance (pre2018) |
| HDI | Concentration index (exports) (value) | UNCTAD (2018). |
| 8.1.2.2 | Competitiveness |  |
| UN | Number of exported goods where Australia has a Revealed Comparative Advantage (RCA) more than 2 | UN Comtrade Database, <https://comtrade.un.org/> EASD calculation |
| 8.1.3 | Economic diversity |  |
| XXX | Nil at present | Nil |
| 8.1.4 | Economic complexity |  |
| GII | 6.2.5 High- & medium-high-tech manufactures, % | United Nations Industrial Development Organization (UNIDO), Industrial Statistics Database, 3- and 4-digit level of International Standard Industrial Classification ISIC Revision 3 (INDSTAT4 2016); OECD, Directorate for Science, Technology and Industry, Economic Analysis and Statistics Division, ‘ISIC REV. 3 Technology Intensity Definition: Classification of Manufacturing Industries into Categories Based on R&D Intensities’, 7 July 2011 (2006–14). (<http://www.unido.org/statistics.html> ; <http://unstats.un.org/unsd/cr/registry/regcst.asp?cl=27> ; <http://www.oecd.org/sti/ind/48350231.pdf> ) |
| AISR | Economic Complexity Index⁷ | Center for International Development at Harvard University (2016) Atlas of Economic Complexity, 2016, URL: <http://atlas.cid.harvard.edu/>; |
| 8.1.5 | Investment |  |
| HDI | Net official development assistance received (% of GNI) | World Bank (2018a). |
| HDI | Private capital flows (% of GDP) | World Bank (2018a). |
| HDI | Remittances, inflows (% of GDP) | World Bank (2018a). |
| 8.1.5.1 | Foreign investment |  |
| GII | 5.3.1 Intellectual property payments, % total trade | WTO, Trade in Commercial Services database, based on the sixth (2009) edition of the International Monetary Fund’s Balance of Payments Manual and Balance of Payments database (2009–15). (<http://stat.wto.org/StatisticalProgram/WSDBStatProgramSeries.aspx> ; <http://www.oecd.org/std/its/EBOPS-2010.pdf> ) |
| GII | 5.3.2 High-tech imports less re-imports, % total trade | United Nations, COMTRADE database; Eurostat, Annex 5: High-tech aggregation by SITC Rev. 4, April 2009 (2010–15). (<http://comtrade.un.org/> ; <http://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an5.pdf> ) |
| GII | 5.3.3 ICT services imports, % total trade | WTO, Trade in Commercial Services database, based on the sixth (2009) edition of the International Monetary Fund’s Balance of Payments Manual and Balance of Payments database (2009–15). (<http://stat.wto.org/StatisticalProgram/WSDBStatProgramSeries.aspx>; <http://www.oecd.org/std/its/EBOPS-2010.pdf>) |
| GII, HDI | 5.3.4 FDI net inflows, % GDP | International Monetary Fund, International Financial Statistics and Balance of Payments databases, World Bank, International Debt Statistics, and World Bank and OECD GDP estimates; extracted from the World Bank’s World Development Indicators database (2013–15). (<http://data.worldbank.org/> ) |
| 8.2 | ENVIRONMENTAL |  |
| AISR, HDI | Renewable electricity, % total electricity generation | OECD (2016–17) Green growth indicators, 2016–2 to 2017, URL: <http://www.oecd.org/>; World Bank (2018a) |
| GII | Environmental performance | Yale University and Columbia University Environmental Performance Index 2016. (<http://epi.yale.edu/>) |
| HDI | Carbon dioxide emissions, per capita (tonnes) | World Bank (2018a) |
| HDI | Carbon dioxide emissions (kg per 2011 PPP $ of GDP) | World Bank (2018a) |
| HDI | Forest area (% of total land area) | World Bank (2018a) |
| HDI | Forest area, change (%) | World Bank (2018a) |
| HDI | Fossil fuel energy consumption (% of total energy consumption) | World Bank (2018a) |
| HDI | Fresh water withdrawals (% of total renewable water resources) | World Bank (2018a) |
| 8.3 | SOCIAL |  |
| HDI | Human Development Index | [Human Development Reports](http://hdr.undp.org/en/composite/HDI#b) |
| 8.4 | GOVERNANCE RELATED |  |
| XXX | Nil at present | Nil |

# Appendix G: Governance of the Review

The positions given below were the positions that contributors to the Innovation Metrics Review held at the time of their contribution.

## Innovation Metrics Review Steering Committee

* Dr Alan Finkel, Australia’s Chief Scientist, Co-Chair
* Mr Mark Cully, Chief Economist, Co-Chair, Australian Department of Industry, Innovation and Science
* Dr Charles Day, Chief Executive Officer, Office of Innovation and Science Australia
* Ms Luise McCulloch, Deputy Australian Statistician, Statistical Services Group, Australian Bureau of Statistics
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# Appendix H: Scorecard metrics descriptions and data coverage

Table H.1: Scorecard metrics descriptions

| Innovation metrics | | | Definition | Source |
| --- | --- | --- | --- | --- |
| Business activities | **Inputs** | [1] Total expenditure on innovation by businesses, % of GDP  (this measure is a proxy for business investment in knowledge-based capital and physical capital as an input) | Total innovation expenditure incurred by Australian businesses includes both research and development (R&D) and non-R&D innovation.  This is a calculation based on the total innovation expenditure incurred by Australian businesses, published by the ABS. It is sourced from the BCS. For the purposes of this scorecard, this value was then converted to a percentage of GDP.  An estimated total for innovation expenditure was derived by assigning a random value to each innovation-active business that reported expenditure within the bounded ranges. These data, and the values of those businesses that reported actual dollar values, were then weighted to derive an innovation expenditure total. This simulation was run multiple times and an average of these simulations provides an approximate value of innovation expenditure.  Australian data are presented as the median value of the upper and lower ranges for the innovation expenditure value published by the ABS. | ABS BCS – Cat. No. 8158.0 – Innovation in Australian Business (further ABS calculation); Gross Domestic Product: Current prices; ABS Cat No. 5206.0 – Australian System of National Accounts. International comparison data are available via Eurostat: Innovation activities and expenditures, Community Innovation Survey (CIS), Eurostat: Gross domestic product at current market prices. |
| [2] Business expenditure on research and development (BERD), % of GDP  (this measure is a proxy for business investment in knowledge-based capital as an input) | Business expenditure on R&D (BERD) includes all expenditure on R&D performed by business enterprises, irrespective of funding sources. | ABS Cat. No. 8104.0 – Research and Experimental Development, Businesses, Australia. International comparison data are available via OECD MSTI. |
| [3] Investment in knowledge-based capital (ICT, R&D and other intellectual property products), % of GDP  (this measure is a proxy for business investment in knowledge-based capital as an input) | ICT investment in the System of National Accounts includes the following key areas: investment in computer hardware, telecommunication equipment, computer software and databases, R&D and other IP products. | ABS Cat. No. 5204.0 – National Accounts. International comparison data are available from the [Measuring the Digital Transformation (OECD 2019)](https://doi.org/10.1787/888933930193). |
| [4] Diffusion of selected ICT tools and activities in enterprises (cloud computing), % of all businesses with 10+ employees  (this measure is a proxy for the diffusion of digital technologies in business as an input) | Diffusion of selected ICT tools and activities in enterprises provides the percentage of businesses that reported using selected ICT tools, in this case, the metric specifies the use of paid cloud computing.  Data on cloud computing services are gathered through direct surveys of ICT usage by businesses through the BCS. The reported data specifies the percentage of businesses that reported they used paid cloud computing. This is being used as a proxy for the diffusion of ICT tools.  Cloud computing is the only advanced metric that Australia currently has a time series available to measure ICT diffusion. However, it is expected this indicator will be revised after mid 2022 if improvements are made to capture the diffusion of other ICT tools, such as Big Data, the Internet of Things, and other items in accordance with international practices, as recommended in Chapter 4.  This metric looks at businesses with 10 or more employees, as do a number of others below, because the Community Innovation Surveys used internationally collect data on businesses with 10 or more employees. International comparison data on businesses with 9 or fewer employees are generally not available. | ABS BCS – Cat. No. 8129.0 – Business Use of Information Technology and 8167.0 – Selected Characteristics of Australian Businesses. Australian data are sourced from ABS customised data and are for businesses with 10+ employees. International comparison data are available via the OECD, ICT Access and Usage by Businesses Database, 2018. |
| [5] Businesses collaborating on innovation, % of all businesses with 10+ employees  (this measure is a proxy for inputs into business investment in management practices and business organisation) | This reports on the proportion of businesses with 10 or more employees that collaborated for the purposes of innovation as a percentage of all businesses.  This annual figure on the Scorecard is calculated based on the proportion of all businesses that are innovative (55.9% – OECD table 1). This proportion is multiplied with the proportion of innovative businesses that have collaborated for the purposes of innovation (22.5% – OECD table 15) = (12.6% of all businesses with 10+ employees). | ABS Cat. No.8158.0 (superceded by 8167.0) – Australian data are sourced from ABS customised data and are for businesses with 10+ employees. International comparison data are available via OECD innovation indicators (http://www.oecd.org/sti/inno-stats.htm). |
| **Outputs** | [6] Proportion of businesses with more than 25% of income from sales due to innovation, % of all businesses with 10+ employees  (this measure is a proxy for multiple productivity drivers including physical, human and knowledge-based capital as outputs) | This reports the proportion of businesses with 10 or more employees that have reported more than 25% income from sales from innovative products introduced by the company in the previous year.  While the data is based on self-assessment, it is the best that is currently available. The OECD will be investigating similar intensity-based metrics in their forthcoming release (Q4 2019) and this may provide an internationally comparable data source for future scorecards. The metric will be reviewed when further international data is available. | ABS Cat. No.8158.0 (superceded by 8167.0) – Australian data are sourced from ABS customised data and are for businesses with 10+ employees. (Goods and Services Innovation Cube, table 6, further ABS calculation) |
| [7] High-growth enterprise rate based on sales growth, % of all businesses with 10+ employees  (this measure is a proxy for economies of scale and scope) | High-growth enterprises have an average annualised sales revenue growth of over 20% per year over a 3-year period, and had 10 or more employees at the beginning of the observation period. | Australian data are sourced from ABS BLADE customised data. A summary of these data is available on the [AIS](file://prod.protected.ind/dochub/DocHubShare/EAS/Business%20Functions/Data%20and%20Analytical%20Services/Innovation%20Research/AIS-Beta/entrepreneurship/firm-growth/index.html) Monitor. International comparison data are available at the OECD Structural and Demographic Business Statistics (SDBS) database on high growth enterprise rates. |
| [8] Intellectual property rights filed overseas per billion GDP (constant 2010 US$)  (this measure is a proxy for business investment in knowledge-based capital as an output) | The sum of the number of patent, trade mark (by class), industrial design (by class) and plant breeders’ rights applications filed at another country’s IP office by a country’s residents in a given year, divided by the country’s GDP (constant 2010 US$).  The filing of IP rights abroad signals export intentions, which in turn suggests the production of globally competitive products and services. Counting all IP rights includes innovative ideas across the economy, enabling comparison of a country’s performance in generating innovation.  For trade mark and industrial design applications, some offices allow single-class filing only, meaning that applicants have to file a separate application for each class. Others permit multi-class filings, enabling applicants to file a single application in which a number of classes can be specified. To improve international comparisons of the numbers of applications received, each trade mark and industrial design application will be counted for each class they relate to.  Applicants that file IP rights into the corresponding European IP office are counted once, despite the right being applicable for each member country signatory to that IP arrangement. | WIPO IP Statistics Data Center. Total foreign oriented patent applications (direct and PCT) by applicant origin. Total foreign oriented trade mark applications by class (direct and Madrid) by applicant origin. Total foreign oriented industrial design applications by class (direct and the Hague) by applicant origin. Total foreign oriented plant breeders rights applications (UPOV). GDP (constant 2010 US$) from the World Bank. |

| Innovation metrics | | | Definition | Source |
| --- | --- | --- | --- | --- |
| Business environment | **Inputs** | [9] Level of regulatory barriers to firm entry and competition – OECD Product Market Regulation  (this measure is a proxy for the inputs into regulation and competition of businesses) | The OECD Product Market Regulation (PMR) measures the degree to which policies promote or inhibit competition in areas of the product market where competition is viable.  The PMR score is constructed from 18 base indicators that are grouped into two main components; Distortions induced by state involvement, and Barriers to domestic and Foreign Entry.  A lower value indicates a better Product Market Regulation environment. | OECD Product Market Regulation database |
| [10] Venture capital investment (funds invested in businesses), % of GDP  (this measure is a proxy for inputs into trade and investment for business) | The ABS defines VC as investment at the pre-seed, seed, start-up, and early expansion stages of business development. This is a measure of new investment by funds into businesses during the financial year.  Capital investment is vital to help innovative start-ups and young businesses commercialise technologies and turn research into new products. This measures the annual amount of equity investments made to support the pre-seed, seed, start-up and early expansion stages of business development, measured as a percentage of national GDP. | ABS Cat. No, 5678.0 – VC&LSPE. International comparison data are from OECD Entrepreneurship at a Glance. |
| [11] Permanent migrants and non-student temporary entrants with higher education qualifications, % of the labour force  (this measure is a proxy for inputs into demand and supply conditions for labour resources) | The proportion of entrants into Australia, either non-student temporary or permanent, with higher education qualifications. Higher education attainment includes bachelors, masters, doctorates, or equivalent (does not include short-cycle tertiary).  Relates to temporary entrants who were present in Australia on 9 August, 2016 (Census night) and held a temporary visa that was not a student visa.  Relates to migrants who have migrated to Australia under a permanent Skilled, Family, Humanitarian or Other Permanent visa stream and arrived in Australia between 1 January, 2000 and 9 August 2016. | ABS: Cat. No. 3419.0 – Insights from the Australian Census and Temporary Entrants Integrated Dataset, 2016 & ABS Cat. No. 3417.0 – Understanding Migrant Outcomes – Insights from the Australian Census and Migrants Integrated Dataset, Australia, 2016. |
| **Outputs** | [12] Birth rate of employing enterprises, % of business economy  (this measure is a proxy for outputs of competition and regulation) | The OECD’s definition of an employing enterprise birth is the establishment of an enterprise with at least one employee (headcount). This population consists of new enterprises that have at least one employee in the birth year. Enterprises that existed before the year in consideration that did not have one employee but then subsequently established themselves as an employee enterprise are included in the population for the year that they became an employee enterprise (the birth year). Employment excludes non-salaried directors, volunteers, persons paid by commission only, and self-employed persons, such as consultants and contractors.  OECD’s Entrepreneurship at a Glance 2017 indicates that for Australia and the Republic of Korea, enterprise births do not take into account the transition of enterprises from zero employees to one or more employees.  For Australian data, employing enterprise entries into the population do not include entries due to: mergers, break-ups, split-offs or restructuring of a set of enterprises. The scope is limited to only include businesses that are actively trading in the market sector. Business entities with a turnover below $75,000 do not have to register for GST and hence those who have not registered will not be included in these counts. Businesses that have not submitted a Business Activity Statement or have reported zero dollar amounts over five consecutive quarters (or three consecutive years for annual remitters) are treated as 'long-term non-remitters'. These businesses are not considered to be actively trading and are excluded from the counts, as they are not remitting GST (see [ABS explanatory notes](https://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/8165.0Main%20Features2June%202014%20to%20June%202018?opendocument&tabname=Summary&prodno=8165.0&issue=June%202014%20to%20June%202018&num=&view=) for more information).  The employing enterprise birth rate corresponds to the number of births of employing enterprises as a percentage of the population of active enterprises with at least one employee (see [OECD Manual on Business Demography Statistics](http://www.oecd.org/sdd/39974599.pdf)). The SDBS category is the total industry, construction and market services, except holding companies. | ABS Cat No. 8165.0 – Counts of Australian Businesses, International comparison data are from OECD Structural and Demographic Business Statistics (SDBS). OECD Entrepreneurship at a Glance (2017). |

| Innovation metrics | | | Definition | Source |
| --- | --- | --- | --- | --- |
| National environment | **Inputs** | [13] Total expenditure on educational institutions (primary to tertiary), % of GDP  (this measure is a proxy for economy level investment inputs into education) | Financial resources invested in education includes primary, secondary, post-secondary non-tertiary and tertiary sectors. This data includes both general government and private sector expenditure. | Data are sourced from national statistics and harmonised by the OECD for international comparison. OECD Education at a Glance. |
| [14] Gross expenditure on research and development (GERD), % of GDP  (this measure is a proxy for economy level investment inputs into education and infrastructure) | Gross expenditure on R&D (GERD) represents the total expenditure devoted to R&D by the Business, Government, Higher Education and Private Non-Profit sectors. | ABS Cat. No. 8104.0 – Research and Experimental Development, Businesses, Australia. International comparison data at OECD MSTI. |
| [15] Fixed broadband subscriptions per 100 inhabitants, by speed faster than 100 Mbps  (this measure is a proxy for inputs into the development of innovation infrastructure) | The data cover quality of broadband infrastructure as measured by the number of subscriptions for fixed broadband service based on speed of connection expressed in megabits per second (Mbps). This measure is a proxy for network capability but it does not provide the actual performance of broadband connections experienced by subscribers.  This metric uses fixed broadband because a technology neutral broadband infrastructure is unavailable at present. This metric will require reviewing to reflect technology neutral infrastructure beyond fixed broadband (e.g. mobile or 5G technology that is used to provide broadband infrastructure). | ABS Cat. No. 8153.0 Internet Activity; Table 2 – Internet Subscribers by advertised download speed; ABS Cat. No. 3101.0 – Australian Demographic Statistics: Table 1 – Population Change summary: ERP Change Over Previous Year. International comparison data are sourced from the OECD broadband portal, ‘Fixed broadband subscriptions per 100 inhabitants, per speed tiers’ with historical time series data obtained from the OECD publications, the *Digital Economy Outlook 2015, 2017* and *Measuring the Digital Transformation*.  International comparison data are for fixed broadband speeds greater than 100 Mbps. Australian data from ABS Cat. No. 8153.0 are for mobile and fixed broadband with speeds greater than or equal to 100 Mbps. This data source has been used as a proxy for fixed broadband with speeds greater than 100 Mbps because of the negligible number of subscribers with Mobile speeds greater than 100 Mbps and the negligible difference in the reported subscription speeds. |
| **Outputs** | [16] Scores of students in mathematics – OECD PISA  (this measure is a proxy for the output of investment into education at an economy level) | PISA is a triennial international survey that aims to evaluate education systems worldwide by testing the skills and knowledge of 15-year-old students in the subjects of reading, mathematics and science.  The results for science and mathematics at country level are highly correlated. Mathematics has been tracked as Australia’s current educational challenges with regard to mathematics were deemed to be more acute than those for science. | [OECD PISA database](http://www.oecd.org/pisa/data/) |
| [17] Quality-adjusted labour input (qualifications and experience), five-year compound annual growth rate, % of total economy  (this measure is a proxy for the output of investment into education and skills at an economy level) | Quality-adjusted labour input is a measure of the skill composition of workers, usually based on the level of educational attainment and labour market experience. Changes in the quality of labour are calculated using data on employment (number of hours actually worked) and compensation of workers (hourly income) by educational attainment, to determine the annual growth rate.  Changes in labour quality (the quality-adjusted labour input) therefore reflects the changing labour market conditions, which impacts labour input contribution to productivity and growth. For example, an increase in the share of workers with tertiary education and those in their prime age – typically defined as those aged 25 to 54 years (which reflect experience of workers) would result in increased labour productivity. | Conference Board Total Economy Database showing the growth rate of labour input, adjusted for quality (labour quality). The data can be accessed from the Growth Accounting and Total Factor Productivity,  1990–2018, series. The data source provides the level of growth in labour quality in the total economy only, not by sector. |
| [18] Proportion of population aged 25–34 with higher education, %  (this measure is a proxy for investment outputs into education at an economy level) | Higher education attainment includes bachelors, masters, doctorates, or equivalent (not short-cycle tertiary) | ABS Cat. No. 6227.0 – Education and Work, Australia, May 2018, Table 14. International comparison data at OECD Education at a Glance. |

| Innovation metrics | | | Definition | Source |
| --- | --- | --- | --- | --- |
| Impacts |  | [19] Multifactor productivity change, five year compound annual growth rate, % | MFP measures the changes in output per unit of combined inputs of labour and capital. The change or growth in MFP is measured as a 5-year compound annual growth rate. | [OECD Multifactor Productivity](https://data.oecd.org/lprdty/multifactor-productivity.htm). |

Table H.2: Scorecard data coverage

| Innovation metrics  = Country present in series  † = Break in data series  = Data not available or considered  = Top 5 country | | | Australia | Austria | Belgium | Brazil | Bulgaria | Canada | Chile | China | Croatia | Cyprus | Czech Republic | Denmark | Estonia | Finland | France | Germany | Greece | Hungary | Iceland | India | Ireland | Israel | Italy | Japan | Korea Republic | Latvia | Lithuania | Luxembourg | Malta | Mexico | Netherlands | New Zealand | Norway | Poland | Portugal | Romania | Russia | Slovak Republic | Slovenia | South Africa | Spain | Sweden | Switzerland | Turkey | United Kingdom | United States |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Business activities | **Inputs** | [1] Total expenditure on innovation by businesses, % of GDP |  |  |  |  |  |  |  |  |  |  |  |  |  | † |  |  | † |  |  |  | † |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | † |  |  |  |  | † | † |  |
| [2] Business expenditure on research and development (BERD), % of GDP | † | † |  |  |  |  | † |  |  |  |  | † |  |  |  |  |  |  | † |  |  |  |  |  |  |  |  | † |  | † |  | † |  |  |  |  |  |  |  |  |  | † | † |  |  |  |
| [3] Investment in knowledge-based capital (ICT, R&D and other intellectual property products),  % of GDP |  |  |  |  |  | † | † |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | † |  | † |  |  |  |  |  | † | † | † |  |  |  |  |  |  |  |  |  |  |  |  |
| [4] Diffusion of selected ICT tools and activities in enterprises  (cloud computing), % of all businesses with 10+ employees | † | † |  | † |  | † |  |  |  |  |  |  | † |  | † | † |  |  | † |  |  |  | † | † | † |  |  | † |  |  |  |  |  |  |  |  |  |  |  |  |  | † | † | † | † |  |
| [5] Businesses collaborating on innovation, % of all businesses with 10+ employees |  |  |  |  |  |  |  | † |  |  |  |  |  |  |  |  | † |  | † |  |  | † |  |  |  |  | † | † |  | † |  | † |  |  |  |  | † |  |  | † |  |  |  |  |  | † |
| **Outputs** | [6] Proportion of businesses with more than 25% of income from sales due to innovation, % of all businesses with 10+ employees |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| [7] High-growth enterprise rate based on sales growth,  % of all businesses with 10+ employees |  |  |  |  |  | † |  |  |  |  |  | † |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | † |  |  | † |  | † |  |  | † |  |  | † |  |  | † |  |  | † |  |
| [8] Intellectual property rights filed overseas per billion GDP  (constant 2010 US$) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Business environment | **Inputs** | [9] Level of regulatory barriers to firm entry and competition – OECD Product Market Regulation |  |  |  | † | † |  | † | † | † |  |  |  | † |  |  |  |  |  |  | † |  | † |  |  |  | † | † | † | † |  |  |  |  |  |  | † | † | † | † | † |  |  |  |  |  |  |
| **Outputs** | [10] Venture capital investment (funds invested in businesses),  % of GDP |  |  | † |  |  | † |  |  |  |  | † | † | † | † | † | † | † | † |  |  | † | † | † | † |  | † | † | † |  |  | † | † | † | † | † |  |  | † | † |  | † | † | † |  | † |  |
| [11] Permanent migrants and  non-student temporary entrants  with higher education qualifications,  % of the labour force |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| [12] Birth rate of employing enterprises, % of business economy |  |  | † |  |  | † |  |  |  |  |  | † |  | † |  | † | † |  |  |  | † |  |  |  |  |  | † |  |  |  |  |  | † | † |  |  |  | † |  |  |  | † | † |  | † |  |
| National environment | **Inputs** | [13] Total expenditure on educational institutions (primary  to tertiary), % of GDP |  | † | † |  |  |  |  |  |  |  |  | † | † | † |  | † | † | † |  |  |  |  |  | † | † |  | † | † |  | † |  | † | † |  |  |  |  |  | † |  |  |  | † | † | † | † |
| [14] Gross expenditure on research and development (GERD), % of GDP | † |  |  |  |  |  | † |  |  |  |  | † |  |  |  |  |  |  | † |  | † |  |  |  |  |  |  | † |  | † |  | † | † |  |  |  |  |  |  |  |  | † | † |  |  |  |
| [15] Fixed broadband subscriptions per 100 inhabitants, by speed faster than 100 Mbps |  |  |  |  |  |  | † |  |  |  |  |  |  |  |  |  |  |  |  |  |  | † |  | † | † | † | † | † |  | † |  |  |  | † |  |  |  |  |  |  |  |  |  |  |  |  |
| **Outputs** | [16] Scores of students in mathematics – OECD PISA |  | † |  |  |  |  | † |  |  |  |  |  | † |  |  |  |  |  |  |  |  | † |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | † |  |  |  |  |  | † |  |
| [17] Quality-adjusted labour input (qualifications and experience), five year compound annual growth rate, % of total economy |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| [18] Proportion of population aged 25–34 with higher education, % |  |  |  |  |  |  | † |  |  |  |  |  |  |  |  |  |  |  |  |  | † | † |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Impacts |  | [19] Multifactor productivity change, five year compound annual growth rate, % |  | † |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | † |  |  |  |  |  |  | † |  |  |  |  | † |  | † |  |  |  |  |  | † |  |  |  |  |  |

# Appendix I: Sources of data and metrics currently available

This is a summary of the key innovation-related sources of data and metrics currently being used by the Australian Government, highlighting where there are opportunities to make changes to increase existing utility.

## Survey data

| Survey of Research and Experimental Development (R&D Survey) | |
| --- | --- |
| Type | Suite of surveys |
| Agency | Australian Bureau of Statistics (ABS) |
| Description | The Survey of Research and Experimental Development is the collective name of a suite of ABS surveys on R&D. The surveys cover R&D expenditure by businesses[[221]](#footnote-222), higher education[[222]](#footnote-223), the Australian, state and territory governments[[223]](#footnote-224), and by the private non-profit sector[[224]](#footnote-225).  R&D, as collected by the ABS, is defined in accordance with the OECD’s Frascati Manual, as:  *‘Creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge’.* [[225]](#footnote-226)  This definition allows a broader range of R&D to be reported to the ABS than may be reported for the Research and Development Tax Incentive (RDTI). |
| Scope and coverage | Business:   * all businesses with intramural expenditure on R&D greater than $100,000 in the reference period are in scope of the survey * collection of data is undertaken based on a stratified random sample of businesses in scope.   Higher Education:   * Survey is a complete enumeration of the higher education institutions * The OECD definition of the higher education sector encompasses universities and other institutions of post-secondary education regardless of their source of finance or legal status. The scope of the ABS R&D survey is based on the OECD definition, but excludes Technical and Further Education colleges.   Government and Private Non-Profit:   * Survey is a complete enumeration of Australian government (Australian and state and territory) and private non-profit organisations with intramural expenditure on R&D during the reference period. |
| Frequency | Australian data on R&D expenditure is collected and published two-yearly on asynchronous collection between sectors (business, higher education, government and private-NPIs). |
| Key innovation-related outputs | Expenditure and human resources devoted to research and experimental development (R&D) carried out by business, higher education, government and private non-profit organisations in Australia, classified by employment size, type of expenditure, type of resource, location of expenditure, source of funds, type of activity, fields of research and socio-economic objective.  The ABS R&D surveys provide key headline metrics such as:   * Gross Expenditure on R&D (GERD) [ABS Cat. No. 8104.0] * Business Expenditure on R&D (BERD) [ABS Cat. No. 8104.0] * Higher Education Expenditure on R&D (HERD) [ABS Cat. No. 8111.0] * Government Expenditure on R&D (GOVERD) [ABS Cat. No. 8109.0] * Private Non-Profit Expenditure on R&D (PNPERD) [ABS Cat. No. 8109.0]. |
| Current use | * Measures of business expenditure on R&D allow the Government to assess the effectiveness of policies and programs, such as the RDTI * International benchmarking through the OECD MSTI publication |
| Current limitations and future opportunities | * Access to annual indicators of GERD and BERD would allow policymakers to adjust policies and programs related to R&D in a timelier manner * Current sample sizes limit the scope for analysis at the 4-digit ANZSIC, Field of Research (FOR) and Socioeconomic Objective (SEO) level * More granular information on the ANZSIC, Field of Research (FOR) and Socioeconomic Objective (SEO) would enable policy analysts to align the strategic research priorities of the publicly funded research sector with business direction and track research and innovation in sectors that are considered strategic priorities for Australia. Additionally, there is strong policy interest in assessing expenditure on R&D in Australia by foreign-owned businesses. |

| Business Characteristics Survey (BCS) | |
| --- | --- |
| Type | Survey |
| Agency | Australian Bureau of Statistics (ABS) |
| Description | The key national survey used for innovation measurement is the BCS[[226]](#footnote-227). It goes beyond R&D to collect information about the use of information technology[[227]](#footnote-228), types of innovation and the innovation expenditure by Australian businesses. The BCS collects information from businesses about the broad types and status of innovation undertaken by Australian business in a one-year reference period.  The BCS draws on the conceptual definitions and guidelines included in the Oslo Manual[[228]](#footnote-229) This manual provides a framework for the collection of innovation statistics and specifies the definitions of innovating businesses and innovation-active businesses that are used by the ABS. The BCS draws on this manual for the questions used in the BCS and in the presentation of outputs from the survey. |
| Scope and coverage | All employing business entities in the Australian economy are in scope of the survey, except for:  SISCA 3000 General government  SISCA 6000 Rest of the world  ANZSIC06 Division O Public administration and safety  ANZSIC06 Division P Education and training  ANZSIC06 Groups 624 (Financial asset investing) and 633 (Superannuation funds)  ANZSIC06 Groups 954 (Religious services) and 955 (Civic, professional and other interest group services)  ANZSIC06 Subdivision 96 Private households employing staff  Collection of data is undertaken based on a random sample of in scope businesses. |
| Frequency | The BCS is an annual survey and produces point in time estimates for: use of information technology; innovation; and a broad range of other non-financial business characteristics[[229]](#footnote-230).  The survey produces core annual use of IT and innovation indicators, with a more detailed set of items for each of these topics collected every second year (i.e. in alternating years). |
| Key innovation-related outputs | ABS Cat. No. 8167.0 – Characteristics of Australian Businesses  ABS Cat. No. 8158.0 – Innovation in Australian Businesses  ABS Cat. No. 8129.0 – Business Use of Information Technology  ABS Cat. No. 8168.0.55.001 0 Microdata: Business Characteristics, Australia  Key indicators of innovation include:   * measures of business innovation (innovating, innovation-active) * types of innovation (goods or services, operational processes, organisational/managerial processes, marketing methods) * status of innovation (introduced, still in development, abandoned) * innovation expenditure * collaboration on innovation.   Key indicators of IT use include:   * main type of internet connection * importance of digital technologies * web presence and social media presence and use * IT support * extent of IT use in business processes * cloud computing use * incidence and impact of internet security incidents or breaches * internet commerce.   Key indicators of business characteristics include:   * business structure and operations * business finance * markets and competition * skills used, skills shortages and deficiencies. |
| Current use | * Indicators of innovation in Australian businesses are important to researchers and policymakers in building an understanding of the drivers and impacts of innovation * Indicators of IT use in Australian businesses inform researchers and policymakers of the extent of technology diffusion, adoption, use and impacts of digital technologies in businesses * International benchmarking through the OECD STI scoreboard publication. |
| Current limitations and future opportunities | * Differences in business innovation survey methodology used in Australia versus other countries in the OECD limit the ability to compare data internationally. For example, Australia uses a single financial year reference period while innovation surveys in most other countries use a two or three-year reference period * An improved evidence base is needed to understand business expenditure on non-R&D innovation-related activities. In Australia, estimates (in expenditure ranges) of innovation expenditure are collected through the BCS. The utility of this data is limited and collecting data that would support the production of a value estimate instead of a range would meet user needs better * Current measures of business collaboration may exclude significant business collaboration arrangements in some sectors of the economy (for example, information on fee-for service arrangements should be collected and published separately) * Opportunities have been identified to present existing business innovation data in new ways; complementing existing measures and providing a more complete picture of the relative impacts of innovation activities occurring in Australian businesses * Current Australian Bureau of Statistics survey content related to digital technology usage covers a limited scope of new technologies. There is opportunity to Review and update the content to reflect technological advancements and their impact on business performance * The BCS sample is designed to produce efficient estimates for industry and employment size at the national level and thus it does not provide quality estimates for states/territories. There is demand from state and territory governments for indicators to evaluate innovation policies and programs implemented at state or territory level. |

| Management Capabilities Module (MCM) | |
| --- | --- |
| Type | Survey collected as a module of the BCS |
| Agency | Australian Bureau of Statistics (ABS) |
| Description | The ABS was funded by DIIS to conduct the MCM.[[230]](#footnote-231) The survey instrument was developed in collaboration with the UTS.  The survey module was designed to support international comparisons of management practices and the analysis of the impact of different levels of management sophistication on business productivity and performance.  Similar international surveys have collected information about the manufacturing industry. The MCM is the first to collect this data for the whole economy. |
| Scope and coverage | All employing business entities in the Australian economy are in scope of the survey, except for:  SISCA 3000 General government  SISCA 6000 Rest of the world  ANZSIC06 Division O Public administration and safety  ANZSIC06 Division P Education and training  ANZSIC06 Groups 624 (Financial asset investing) and 633 (Superannuation funds)  ANZSIC06 Groups 954 (Religious services) and 955 (Civic, professional and other interest group services)  ANZSIC06 Subdivision 96 Private households employing staff  Collection of data is undertaken based on a random sample of in scope businesses |
| Frequency | One-off user-funded collection run in the 2015–16 reference period |
| Key innovation-related outputs | ABS Cat. No. 8172.0 – Management and Organisational Capabilities of Australian Business  The MCM provides baseline data on management and organisational capabilities of Australian businesses. It presents statistics on a selection of topics, including: key performance indicators; use of data in decision making; strategic plans; skills; supply chain; environmental management; and demographic information related to the Principal Manager.  Data was also released as a Confidentialised Unit Record File (CURF) |
| Current use | The survey is a resource to help researchers:   * examine management practices in Australian businesses * analyse management capability and its impact on productivity and economic growth * evaluate industry programs that focus on management capability * benchmark Australian management capability against the USA and other countries.   The data provided by this survey has been used in business analysis.[[231]](#footnote-232) |
| Current limitations and future opportunities | * Currently, the international comparability of this data is limited. A similar survey was run in the US in the manufacturing sector (2011 and 2016), but the MCM was the first national survey to collect this type of information across a whole economy * Users have indicated that minor changes could be made to the survey content of the MCM. The MCM provides meaningful measures that would support policy development in this space. They have also indicated that some questions are much more valuable than others in generating policy-relevant information. |

| National Survey of Research Commercialisation (NSRC) | |
| --- | --- |
| Type | Survey |
| Agency | Department of Industry, Innovation and Science (DIIS) |
| Description | The NSRC[[232]](#footnote-233) is a national survey on the research engagement and commercialisation activities of publicly funded research organisations (PFROs) in Australia. It is the primary source of information on the publicly funded research sector’s efforts to collaborate with industry to transfer knowledge and commercialise research.  The NSRC collects data on the commercialisation activities of PFROs and measures the extent to which public researchers have successfully translated their ideas into valuable technologies, services, business models and other IP.  The current suite of questions draws on some concepts collected in international surveys run by the AUTM (the leading association of technology transfer professionals) in the US and Canada that measure trends and share research commercialisation insights about the technology transfer industry and those who work in it. However, there is currently no international framework for the measurement of research commercialisation activities. |
| Scope and coverage | The target population for the NSRC primarily consists of research organisations which:   * undertake their own research rather than commissioning it from other organisations * receive public funding for research (this excludes research service providers that are funded entirely through contracts with research users) * are not-for-profit (this excludes businesses that receive public funding through the R&D Tax Incentive) * have an Australian Business Number (ABN) or Australian Company Number (ACN) (this excludes sub-units within universities). |
| Frequency | Since its inception in 2001, the NSRC has been undertaken either biennially or annually.  It is not currently funded for any future cycles. |
| Key innovation-related outputs | The data collected covers:   * investment in R&D, commercialisation staff and training * commercialisation pathways: licenses, start-ups, patents and disclosures, consultancies, contracts and collaborations.   The data are released in both aggregate and at the unit-record level |
| Current use | The 2016 NSRC Snapshot states that the dataset is widely used to understand trends, priorities and gaps by a range of stakeholders, including Australian and state governments, international bodies, universities, medical research institutes, publicly funded research agencies and peak bodies. It is used for policy, planning and benchmarking by research organisations, industry and government*’*  A key use of the data is by the PFROs to compete publicly in terms of their research commercialisation outcomes.  However, user consultation has determined that the NSRC currently meets few of the needs of policymakers to progress research commercialisation for public good reasons. It collects some innovation data, modelled on internationally comparable data, that would be deemed important by stakeholders if the data quality was higher. |
| Current limitations and future opportunities | Two issues need to be resolved to provide fit for purpose research commercialisation data for policy making:   * determining what should be measured to determine the success of PFRO in terms of translation and commercialisation of ideas, and agreeing definitions that support this * addressing the data quality issues of a subset of PFRO, to ensure the statistics generated are fit for use. The latter will require investment by these organisations. |

| Survey of Venture Capital and Later Stage Private Equity (VC&LSPE) | |
| --- | --- |
| Type | Survey |
| Agency | Australian Bureau of Statistics (ABS) |
| Description | The survey provides details of VC&LSPE activity from VC&LSPE fund managers.  The survey is fully funded by the Department of Industry, Innovation and Science. |
| Scope and coverage | The VC&LSPE survey[[233]](#footnote-234) aims to have full coverage of all resident VC&LSPE funds (vehicles) in enterprises that meet the following definitions of VC&LSPE:   * VC is defined as high risk private equity capital for typically new, innovative or fast growing unlisted companies in the pre-seed, seed, start-up, or early expansion stage. A VC investment is usually a short to medium-term investment with a divestment strategy with the intended return on investment, mainly in the form of capital gains (rather than long-term investment involving regular income streams) * Later Stage Private Equity (LSPE) is defined as investment in companies in the late stage of expansion, turnaround and buy-out or sale stage of investment. These companies are still being established, the risks are high and investors have a divestment strategy with the intended return on investment mainly in the form of capital gains (rather than long-term investment involving regular income streams). |
| Frequency | Annual |
| Key innovation-related outputs | ABS Cat. No. 5678.0 VC&LSPE, Australia.  Information includes: commitments and drawdowns by source of funds, assets and liabilities of the VC&LSPE investment vehicles; capital flows between the vehicles, investors and investee companies; and characteristics of VC investee companies. |
| Current use | VC investment, % of GDP is a key indicator of the annual amount of equity investments made to support the pre-seed, seed, start-up and early expansion stages of business development.  Measures of VC investment allow the Government to assess the effectiveness of policies and programs to improve access to capital for innovation |
| Current limitations and future opportunities | Policymakers are interested in understanding business access to finance and other forms of investment (including VC; but also angel investors, crowd-sourced equity funding, grants, accelerators and venture debts) for start-ups. These types of investment are not currently in scope due to the difficulty in identifying businesses engaged in this activity.  There is a strong preference for internationally comparable data. Policymakers are unclear if Australian businesses have more difficulty obtaining access to finance than their international counterparts. However, there are currently no internationally agreed upon definitions of the stages of VC. |
| Counts of Australian Businesses, including Entries and Exits (CABEE) | |
| Type | Administrative |
| Agency | Australian Bureau of Statistics (ABS) |
| Description | This publication presents counts of businesses based on snapshots of actively trading businesses from the Australian Bureau of Statistics Business Register (ABSBR). This publication contains counts and rates of business entries and exits from the Australian economy as well as counts and rates pertaining to the survival of businesses. |
| Scope and coverage | All actively trading businesses from the ABSBR. |
| Frequency | Annual |
| Key innovation-related outputs | ABS Cat. No. 8165.0 – Counts of Australian Businesses including Entries and Exits.[[234]](#footnote-235)  Business birth, death and survival rates. |
| Current use | Birth and death rates provide an indication of the rate at which businesses are created and existing businesses close down. This supports analysis of business dynamism and its contribution to productivity growth.  The rate of business entries (or births) is seen as a key determinant of employment and output growth and increasing competitiveness. |
| Current limitations and future opportunities | The quality of birth rates is higher than that of death rates due to the difficulty of separating mergers and acquisitions from deaths.  There is interest from stakeholders in more reliable information about net births. |

| Programme for International Student Assessment (PISA) and  Programme for the International Assessment of Adult Competencies (PIACC) | |
| --- | --- |
| Type | Surveys |
| Agency | Organisation for Economic Co-operation and Development (OECD) |
| Description | PISA is an international survey that aims to evaluate education systems worldwide by testing the skills and knowledge of 15-year-old students in the subjects of reading, mathematics and science.[[235]](#footnote-236)  PIACC[[236]](#footnote-237) is an international survey of adults’ proficiency in literacy, numeracy and problem solving and gathers information and data on how adults use their skills at home, at work and in the wider community. |
| Scope and coverage | The desired base PISA target population in each country consists of 15-year-old students attending educational institutions in grades 7 and higher.  The target population for PIACC is adults aged 16 to 65. The survey samples 5000 individuals in each participating country. |
| Frequency | PISA is run every three years  PIACC is run every 10 years |
| Key innovation-related outputs | [PISA](http://www.oecd.org/pisa/data/)’s headline indicator is the average performance for the three subject areas: science, mathematics and reading.  [PIACC](https://www.oecd.org/skills/piaac/) provides measures of adults' performance in literacy, numeracy, and problem solving in technology-rich environments. |
| Current use | Assessing the performance of the Australian education and training systems relative to other OECD countries. Educational outcomes are linked to productivity growth. |
| Current limitations and future opportunities | N/A |

| Population Surveys | |
| --- | --- |
| Type | Surveys and integrated datasets |
| Agency | ABS |
| Description | There are a number of population surveys that produce key demographic information relevant to innovation policy  For example, the Census of Population and Housing[[237]](#footnote-238) collects information on topics such as education, participation in the labour force, occupations and industries. This data has also been linked to Temporary Visa Holder data[[238]](#footnote-239) from the Department of Home Affairs to provide insights into the characteristics of temporary residents in Australia that was previously not available, including employment and skills.  More frequent collections, such as the ABS Labour Force Survey,[[239]](#footnote-240) also provide key insights into the occupations and qualifications of the workforce. |
| Scope and coverage | Australian population |
| Frequency | The Census is run every five years  Labour Force data are produced quarterly |
| Key innovation-related outputs | Population surveys provide key measures of human capital, such as level of education, occupations and qualifications of the working population.  They also provide measures of the temporary or permanent migration of labour and skills within and in and out of Australia  These measures are found in:   * various Census products * ABS Cat. No. 6291.0.55.003 – Labour Force, Australia * ABS Cat. No. 3417.0 – Understanding Migrant Outcomes – Insights from the Australian Census and Migrants Integrated Dataset * ABS Cat. No. 3419.0 – Insights from the Australian Census and Temporary Entrants. |
| Current use | The stock (and flows) of human capital (e.g. skills and qualifications of the population) can affect productivity and growth by facilitating innovation.  These measures enable the Government to evaluate the effectiveness of policies and programs designed to support skills development and improve education outcomes.  Measures of skilled migration provide insight into how effective Government migration programs are in improving access to skills. |
| Current limitations and future opportunities | There is increasing demand from users to understand the skills, rather than qualifications, of the workforce better. |
| Internet Activity | |
| Type | Survey |
| Agency | Australian Competition and Consumer Commission (ACCC) (Previously conducted by the ABS) |
| Description | The Internet Activity Report[[240]](#footnote-241) provides information on the number of retail services in operation (SIOs) in terms of connection type and download speed, as well as the volume of data downloaded within Australia.  These data are collected due to the ACCC’s Internet Activity Record Keeping Rule (RKR). Previously information on internet activity data was collected by the Australian Bureau of Statistics (ABS) under the now discontinued Internet Activity Survey (IAS). |
| Scope and coverage | The current carriage service providers required to report include Aussie Broadband, Australian Private Networks, Dodo, Harbour ISP, iiNet, IPStar Australia, MyRepublic, Primus, Singtel Optus, SkyMesh, Telstra, TPG and Vodafone Hutchison Australia. |
| Frequency | 6 monthly |
| Key innovation-related outputs | The collected data includes wired broadband, wireless broadband and mobile handset services information regarding retail services in operation (SIOs) and volume of data downloaded by access technology and estimated download speeds. |
| Current use | Provides proxy measures for inputs into the development of innovation infrastructure. This enables the Australian Government to assess the deployment of communications infrastructure, which contributes to productivity-enhancing capabilities. |
| Current limitations and future opportunities | Provides proxy measures for network capability but it does not provide the actual performance of broadband connections experienced by subscribers. |

| Australian National Accounts | |
| --- | --- |
| Type | Publication – The majority of the estimates in the quarterly national accounts are based on the results of sample surveys. |
| Agency | ABS |
| Description | This publication contains estimates of gross domestic product (GDP) and its components, components of state final demand, the national income account, the national capital account and supporting series.  Australia's national accounts statistics[[241]](#footnote-242) are compiled in accordance with international standards contained in the [System of National Accounts](https://unstats.un.org/unsd/nationalaccount/sna2008.asp) (SNA). |
| Scope and coverage | In accordance with international standards contained in the [System of National Accounts](https://unstats.un.org/unsd/nationalaccount/sna2008.asp).[[242]](#footnote-243) |
| Frequency | Quarterly |
| Key innovation-related outputs | The SNA includes some measures of intangible capital (such as R&D, mineral and petroleum exploration, computer software and artistic originals). This is included in the IMR Scorecard as Investment in knowledge-based capital (ICT, R&D and other intellectual property products), % of GDP.  Whilst not all intangible investment necessarily represents innovation, it is an increasing feature of the innovation ecosystem and potentially a key source of underlying economic growth.  These measures are found in:   * ABS Cat. No. 5206.0 – Australian National Accounts: National Income, Expenditure and Product * Investment in knowledge-based capital (ICT, R&D and other intellectual property products), % of GDP |
| Current use | Current use of the measures of intangible capital is limited because not all types of intangible investment are in the scope of the SNA and are therefore not being measured. At present, policymakers do not have a solid evidence base to understand whether the right policy levers are in place to foster accumulation of intangibles and encourage this potential growth. |
| Current limitations and future opportunities | All intangibles in the scope of the SNA are currently measured in the Australian national accounts. However, the data sources and underlying assumptions covering new investment data, price deflators and capital stock have not been reviewed for some time.  At present, the Australian Bureau of Statistics is not measuring all the kinds of intangibles that are outside the current scope of the SNA. |

| Global Entrepreneurship Monitor (GEM) | |
| --- | --- |
| Type | Survey |
| Agency | Global Entrepreneurship Research Association |
| Description | The Global Entrepreneurship Monitor (GEM)[[243]](#footnote-244) is currently the primary source of entrepreneurship data. The innovation data are collected through two streams: the Adult Population Survey (APS) and the NES. Data are reported at both the national and international levels, with around 54 countries participating. |
| Scope and coverage | The APS tracks the entrepreneurial attitudes, activity and aspirations of individuals. It is administered to a minimum of 2000 adults in each country.  The NES monitors nine factors that are believed to have a significant impact on entrepreneurship, known as the Entrepreneurial Framework Conditions (EFCs). It is administered to a minimum of 36 carefully chosen 'experts'. |
| Frequency | Annual |
| Key innovation-related outputs | Total early-stage entrepreneurship activity, % |
| Current use | The OECD publication, Entrepreneurship at a Glance, cites the GEM as being a key data source for metrics in Entrepreneurial capabilities and entrepreneurship culture.  Australian governments invest significant resources into programs designed to support entrepreneurship activity so there is demand for measures that support both domestic analysis of policy and program effectiveness, interjurisdictional comparison across Australian states and territories, and international comparison.  GEM is generally used because there is no alternative that provides a similar level of coverage and claimed comparability. However, the IMR notes the limitations of GEM data due to its small sample size and limited coverage. |
| Current limitations and future opportunities | Consultation with stakeholders highlighted the need for better quality data on entrepreneurship, start-ups and spin-outs and considerable common ground with regard to stakeholder priorities. Confidentialised output from the consultation process run by the Innovation Metrics Review has been provided to the Commercialisation Policy Branch of DIIS, which has engaged a consultant, Colmar Brunton, to see if there is sufficient common ground to agree on concepts, a set of definitions, and a basis for measurement in Australia going forward. |

### Key government administrative and transactional data

| Government Administrative and Transactional data | |
| --- | --- |
| Type | Administrative |
| Agency | Various Australian and state and territory Government agencies |
| Description | Administration and transaction data are collected by the Government primarily for the purposes of program management and service provision. However, data of this kind is also frequently used as part of evaluations and may also be made publicly available.  Examples that may provide innovation-related data include:   * Data collected through delivery of Australian Government programs (e.g. R&D Tax Incentive, Rural R&D Corporations, Cooperative Research Centres Program and the Entrepreneurs’ Program), and state and territory Government programs (e.g. the NSW Government’s Boosting Business Innovation Program and the Innovate Queensland Program * Data collected through delivery of Australian Government grants and funding (e.g. National Health and Medical Research Council (NHMRC) research grants, ARC grants) * Data collected through service delivery of Australian Government agencies (e.g. ATO, IP Australia, Customs) |
| Scope and coverage | Varies |
| Frequency | Varies |
| Key innovation-related outputs | * The Science, Research and Innovation Budget Tables[[244]](#footnote-245) * The NHMRC’s Research Funding Data[[245]](#footnote-246) * The ARC’s Grants Dataset[[246]](#footnote-247) * [The Department of Education’s Research Block Grant Allocations](https://docs.education.gov.au/node/51901)[[247]](#footnote-248) * IP Australia patent databases[[248]](#footnote-249) * ATO data (e.g. Business Activity Statements, Pay As You Go, Business Income Tax Statements) * Customs information on exports and imports |
| Current use | Government administrative and transaction data are frequently used in policy and program evaluation.  A number of Government administrative datasets, such as ATO and IP Australia data, have been linked into BLADE, enhancing their analytical value |
| Current limitations and future opportunities | There may be opportunities to leverage statistical assets and enhance the utility of existing data by making additional datasets available for integration using BLADE |

### Key private sector data sources

As already highlighted, increased digitalisation is providing unprecedented opportunities to source science, technology and innovation data.

Over the course of the Review, a broad range of emerging opportunities were identified to understand the Australian innovation landscape and innovation performance better by making use of non-government transactional data sources and unstructured data sources through Big Data analytic techniques.

Examples of some private sector data sources with potential utility for innovation measurement are summarised in Table I.2. In the short term, the Review identified LinkedIn, Burning Glass, Seek, and Xero to be potentially useful to Australian governments.

Table I.2: Private sector data collections relevant to innovation measurement

| Organisation | Brief description of business model | Data collected and potential utility for innovation measurement |
| --- | --- | --- |
| LinkedIn | LinkedIn is the world’s largest professional network. Members use LinkedIn to advance their careers, connect with professionals and stay informed. LinkedIn offers services that can be used by customers to change the way they hire, market, sell and learn. | LinkedIn is keen to work with the Australian Government, and is currently collaborating with DIIS on projects related to entrepreneurialism, management capability and digital skills. |
| Burning Glass | Burning Glass is an analytics software company that uses AI technology to provide its clients with custom, real-time data analysis on jobs, skills, and the labour market. | Burning Glass collects data on skills (as opposed to qualifications) and labour market data.  Burning Glass Technologies has developed a dynamic, global skills taxonomy based on its analysis of job postings, resumes, and social profiles.[[249]](#footnote-250)  The US Bureau of Labor Statistics uses Burning Glass data to supplement its ‘Occupational Requirements Survey’, reducing research costs and improving the timeliness and granularity of survey questions. |
| Xero | Xero provides cloud-based accounting software that connects small businesses to their advisors and other services.  Its products are based on the Software as a Service (SaaS) model and sold by subscription, based on the type and number of company entities managed by the subscriber. It currently has accounting information from over 1.8 million subscribers. | Xero data can indicate the financial health of a business in close to real time. It includes items such as profitability, payment terms and cash flow.  For example, AlphaBeta has used Xero data to investigate how businesses respond to company tax cuts. |
| SEEK | SEEK has a portfolio of employment, education and volunteer businesses.  SEEK provides:   * a matching service between job seekers and employers * online education * a marketplace for volunteering opportunities. | SEEK collects supply and demand data. |
| JobGetter | JobGetter provides services to job seekers. The company is supported by a grant from the NSW Department of Trade and Investment, and has been named as one of the world’s top HR technology companies.[[250]](#footnote-251) | JobGetter collects supply and demand data. |
| MYOB | MYOB provides a suite of business management products. These include: accounting, payroll, payments, retail point of sale, CRM and professional tax solutions. | MYOB has a large amount of data about customers and suppliers. |
| Facebook | Facebook’s business model is built on harvesting platform data about its users. | Facebook crunches data to generate behavioural inferences that it on-sells, usually to advertisers.  Algorithms functionalise Facebook’s vast body of user data.  Facebook does not sell identifiable data or allow developers access to it.[[251]](#footnote-252) |
| Techboard | Techboard is a directory of Australian start-ups and young tech companies. | Techboard provides data on Australian start-ups and young tech companies. Techboard tracks the companies in its directory and uses this to provide its data reports, including data on funding. |
| League of Scholars | League of Scholars provides bibliometrics data from a range of open public data sources including Google Scholar, Microsoft Academic and Webometrics. | League of Scholars collects data on publications from the global top 5,000 universities and research institutions.  [The 2018 and 2019 NSW Innovation and Productivity Scorecard](https://www.industry.nsw.gov.au/business-and-industry-in-nsw/innovation-and-research/research-series/scorecard) utilised this dataset to produce the metric ‘Percentage of researchers who are in the top 10 of their field’. |
| Crunchbase | Crunchbase holds a database on innovative companies which includes data on funding, exits, and locations of start-ups and investors. | Crunchbase provides free access for academic research.  Crunchbase’s data are partially crowd-sourced, i.e. users can add to and revise contents.  Crunchbase has cross-linked information on companies, their funders, and their staff. |
| Pitchbook | Pitchbook is a private capital market data provider. | Pitchbook collects data via internet scans, i.e. web crawlers that capture financial information from news articles, regulatory filings, websites, and press releases.  Language processing and machine learning technology organises and filters out irrelevant data.  Data are analysed and verified by specialised data teams, to validate information and gather hard-to-find details. |
| Glassdoor | Glassdoor is an international job and recruiting site. | Glassdoor has a growing database of company reviews, CEO approval ratings, salary reports, interview review and questions, and so on. |
| Preqin | Preqin is a private capital and hedge fund data provider. | Preqin Pro provides access to industry private capital and hedge fund data sets and tools. |

Box I.2: Use of LinkedIn data for innovation measurement

| **LinkedIn working with governments**  LinkedIn has expressed interest in working with the Australian Government on a pro-bono basis under a Memorandum of Understanding to provide innovation relevant data and analysis. In mid-2018, LinkedIn presented analyses to DIIS on industry, education and skills. LinkedIn is also currently collaborating with DIIS on research projects about Entrepreneurial Landscapes, Management Capability and Digital Skills.  In partnership with the World Bank, LinkedIn, produces Industry Reports to investigate the geographic spread and growth rate of industries and uncover insights. The Industry Reports provide quarterly updates on countries and regions, enabling the monitoring of small changes over time.  LinkedIn is also currently developing a real-time self-service tool and is testing the value proposition of such a tool. The intention is to enable use of LinkedIn data while protecting the privacy of individuals. LinkedIn’s vision is ‘to create economic opportunity for every member of the global workforce through ongoing development of the world’s first Economic Graph’.[[252]](#footnote-253)  **Policy utility**  LinkedIn’s coverage of different occupations is variable. For example, it has near saturation coverage of digital technology-related occupations but low coverage of agricultural workers. Notwithstanding this, its data could be useful to address data gaps identified by the Review, including the following:   * Labour and skills mobility * Networks and clusters * Technology transfer capability * Entrepreneurialism * Management capability. |
| --- |

# Appendix J: Priority ordering of the recommendations

| Priority | Recommendation |
| --- | --- |
| NECESSARY PRECONDITION | **RECOMMENDATION 4.1:** **ASSIGN RESPONSIBILITY FOR LEADERSHIP OF INNOVATION MEASUREMENT** |
| **RECOMMENDATION 1.1: INTRODUCE ANNUAL INNOVATION SYSTEM REPORTING** |
| VERY HIGH | **RECOMMENDATION 2.3 IMPROVE MEASURES OF BUSINESS INNOVATION ACTIVITIES** |
| **RECOMMENDATION 2.7: INTRODUCE AND IMPROVE MEASURES OF INTANGIBLE CAPITAL** |
| **RECOMMENDATION 2.1: IMPROVE MEASURES OF EXPENDITURE ON R&D** |
| **RECOMMENDATION 2.2: IMPROVE MEASURES OF BUSINESS DIGITAL TECHNOLOGIES USE** |
| **RECOMMENDATION 2.8: INTRODUCE AND IMPROVE MEASURES OF DIGITAL ACTIVITIES IN THE ECONOMY** |
| **RECOMMENDATION 3.1: TAKE A WHOLE-OF-GOVERNMENT APPROACH TO INNOVATION RESEARCH** |
| **RECOMMENDATION 2.4: CONDUCT AN ANNUAL SECTORAL ANALYSIS** |
| **RECOMMENDATION 2.9: MEASURE GOVERNMENT INNOVATION ACQUISITION** |
| HIGH | **RECOMMENDATION 2.5: UPDATE OCCUPATION CLASSIFICATION SYSTEM** |
| **RECOMMENDATION 2.6: UPDATE INDUSTRY CLASSIFICATION SYSTEM** |
| MEDIUM | **RECOMMENDATION 2.10: INTRODUCE AND IMPROVE MEASURES OF ENTREPRENEURSHIP; START-UPS AND SPIN OUTS** |
| **RECOMMENDATION 2.11: IMPROVE MEASURES OF ACCESS TO FINANCE FOR START-UPS** |
| **RECOMMENDATION 2.12: MEASURE LOCATION-BASED INNOVATION** |
| **RECOMMENDATION 2.13: IMPROVE MEASURES OF RESEARCH COMMERCIALISATION** |

# Glossary

| Phrase | Meaning |
| --- | --- |
| Accessibility and clarity | Accessibility may be understood as the ease with which the metric (or its underlying components) can be obtained from it underlying data source. This includes the ease with which the existence of information can be ascertained, as well as the suitability of the form or medium though which the information can be accessed. The cost of the information may also be an aspect of accessibility. |
| Accuracy and validity | Accuracy relates to the degree to which the metric correctly describes the phenomena it was designed to measure (how close it is to the ‘true value’). It is usually characterised in terms of error in statistical elements and is traditionally decomposed into bias (systematic error) and variance (random error) components. It may also be described in terms of the major sources of error that potentially cause inaccuracy. Validity is the extent to which a score represents the variable it is intended to measure. Validity may be affected by the collection method or respondent characteristics. |
| Actors in the innovation system | Actors in the innovation system include government, business, higher education institutions, and not-for-profit organisations. |
| Administrative data | Administrative data is the set of units and data derived from an administrative source, such as business registers or tax files. |
| Artificial intelligence (AI) | Artificial intelligence is a term used to describe the activity and outcome of developing computer systems that mimic human thought processes, reasoning and behaviour. |
| Asset | An asset is a store of value that represents a benefit or series of benefits accruing to the economic owner by holding or using the asset over a period of time. Both financial and non-financial assets are relevant to innovation. Fixed assets are the result of production activities and are used repeatedly or continuously in production processes for more than one year. |
| AUTM | AUTM (formerly known as the Association of University Technology Managers) is the leading association of technology transfer professionals. |
| Big data | Big data has two meanings. In common use it refers to extremely large data sets that may be analysed computationally to reveal patterns, trends and associations. These may be structured, semi-structured, or unstructured. When used by data scientists, it refers to extremely large unstructured data sets. This report uses it to mean unstructured data sets. |
| Brand equity | The commercial value that derives from consumer perception of the brand name of a particular product or service, rather than from the product or service itself. This may positive or negative. |
| Business capabilities | Business capabilities include the knowledge, competencies and resources that a business accumulates over time and draws upon in the pursuit of its objectives. The skills and abilities of a business's workforce are a particularly critical part of innovation-relevant business capabilities. |
| Business expenditure on R&D (BERD) | Business expenditure on R&D (BERD) is the measure of intramural R&D expenditures within the Business enterprise sector during a specific reference period. |
| Business sector | The Business sector comprises:   * All resident corporations, including not only legally incorporated enterprises, regardless of the residence of their shareholders. This group includes all other types of quasi-corporations, i.e. units capable of generating a profit or other financial gain for their owners, recognised by law as separate legal entities from their owners, and set up for purposes of engaging in market production at prices that are economically significant * The unincorporated branches of non-resident enterprises are deemed to be resident because they are engaged in production on the economic territory on a long-term basis * All resident non-profit institutions (NPIs) that are market producers of goods or services or serve business.   This sector comprises both private and public enterprises |
| Business innovation | A business innovation is a new or improved product or business process (or combination thereof) that differs significantly from the business's previous products or business processes and that has been introduced on the market or brought into use by the business. |
| Business innovation activities | Business innovation activities include all developmental, financial and commercial activities undertaken by a business that are intended to result in an innovation for the business. They include:   * research and experimental development (R&D) activities * engineering, design and other creative work activities * marketing and brand equity activities * IP related activities * employee training activities * software development and database activities * activities related to the acquisition or lease of tangible assets * innovation management activities.   Innovation activities can result in an innovation, be ongoing, postponed or abandoned. |
| Business model innovation | Business model innovation relates to changes in a business’s core business processes as well as in the main products that it sells, currently or in the future. |
| Business process innovation | A business process innovation is a new or improved business process for one or more business functions that differs significantly from the business’s previous business processes and that has been brought into use by the business. The characteristics of an improved business function include greater efficacy, resource efficiency, reliability and resilience, affordability, and convenience and usability for those involved in the business process, either external or internal to the business. Business process innovations are implemented when they are brought into use by the business in its internal or outward-facing operations. Business process innovations include the following functional categories:   * production of goods and services * distribution and logistics * marketing and sales * information and communication systems * administration and management * product and business process development. |
| Capital deepening | Growth in capital equipment.  Capital deepening is a situation where the capital per worker is increasing in the economy. This is also referred to as capital intensity. Capital deepening is often measured by the rate of change in capital stock per labour hour. |
| Capital expenditures | Capital expenditures are the annual gross amount paid for the acquisition of fixed assets and the costs of internally developing fixed assets. These include gross expenditures on land and buildings, machinery, instruments, transport equipment and other equipment, as well as intellectual property products. |
| Capital shallowing | Capital shallowing is a situation where the capital per worker is decreasing in the economy. This is also referred to as capital intensity Capital shallowing is often measured by the rate of change in capital stock her labour hour. |
| Chain linking | Chain linking means joining together two time series that overlap in one period by rescaling one of them to make its value equal to that of the other in the same period, thus combining them into a single time series. More complex methods may be used to link together time series that overlap by more than one period. |
| Cloud computing | Cloud computing is the on-demand availability of computer system resources, especially data storage and computing power, without direct active management by the user. The term is generally used to describe data centres available to many users over the Internet. Large clouds, predominant today, often have functions distributed over multiple locations from central servers. |
| Cognitive testing | Cognitive testing is a methodology developed by psychologists and survey researchers which collects verbal information on survey responses. It is used to evaluate the ability of a question (or group of questions) to measure constructs as intended by the researcher and if respondents can provide reasonably accurate responses. |
| Coherence | Coherence related to the degree to which a metrics can be successfully integrated with other statistical information within a broad analytic framework and over time. The use of standard concepts, classifications and target populations promotes coherence, as does the use of common methodology across surveys. |
| Collaboration | Collaboration requires co-ordinated activity across different parties to address a jointly defined problem, with all partners contributing. Collaboration requires the explicit definition of common objectives and it may include agreement over the distribution of inputs, risks and potential benefits. Collaboration can create new knowledge, but it does not need to result in an innovation. |
| Commercialisation | Commercialisation is the process of introducing a new product or production method into commerce – making it available on the market. The term often connotes especially entry into the mass market (as opposed to entry into earlier niche markets), but it also includes move from the laboratory into (even limited) commerce. |
| Community innovation survey (CIS) | The CIS is a harmonised survey of innovation in enterprises co-ordinated by Eurostat and currently carried out every one, two or three years in EU Member States and several European Statistical System (ESS) Member Countries. |
| Comparability | The comparability of a metric will be against one or more international benchmarks. Metrics calculated for Australia only are less useful than those measured by a significant number of other countries, such as the OECD members and reporting partners in the Main Science and Technology Indicators. In addition, metrics may be more or less readily compared. For example, six factors determine the international comparability of Australian innovation indicators obtained from innovation surveys:   * The reference period * Differences in the distribution of businesses by size * Differences in industry structure * Service sector coverage * The design of response categories * Question wording. |
| Composite indicator | A composite indicator compiles multiple indicators into a single index based on an underlying conceptual model in a manner which reflects the dimensions or structure of the phenomena being measured. See also Indicator. |
| Conceptual framework (measurement) | A conceptual framework is an analytical tools with several variations and contexts. It can be applied in different categories of work where an overall picture is needed. It is used to make conceptual distinctions and organise ideas. Strong conceptual frameworks capture something real and do this in a way that is easy to remember and apply. |
| Co-operation | Co-operation occurs when two or more participants agree to take responsibility for a task or series of tasks and information is shared between the parties to facilitate the agreement. See also Collaboration. |
| Corporations | The SNA Corporations sector consists of corporations that are principally engaged in the production of market goods and services. This manual adopts the convention of referring to this sector as the Business enterprise sector, in line with the terminology adopted in the OECD Frascati Manual. |
| Database | A database is an organised collection of data, generally stored and accessed electronically from a computer system. |
| Design | Design is defined as an innovation activity aimed at planning and designing procedures, technical specifications and other user and functional characteristics for new products and business processes. Design includes a wide range of activities to develop a new or modified function, form or appearance for goods, services or processes, including business processes to be used by the business itself. Most design (and other creative work) activities are innovation activities, with the exception of minor design changes that do not meet the requirements for an innovation, such as producing an existing product in a new colour. Design capabilities include the following: (i) engineering design; (ii) product design; and (iii) design thinking. |
| Design right | A registered design protects the visual appearance of a product or item and gives you exclusive rights for that appearance to the extent that, if necessary, there is a legal right to stop an unauthorised party from producing or using your design. |
| Diffusion (innovation) | Innovation diffusion encompasses both the process by which ideas underpinning product and business process innovations spread (innovation knowledge diffusion), and the adoption of such products, or business processes by other businesses (innovation output diffusion). |
| Digital platforms | Digital platforms are ICT-enabled mechanisms that connect and integrate producers and users in online environments. They often form an ecosystem in which goods and services are requested, developed and sold, and data generated and exchanged. Digital platforms capture, transmit and monetise data over the Internet through competitive and collaborative transactions between different users, buyers, or suppliers. |
| Digitalisation | Digitalisation entails the application of digital technologies to a wide range of existing tasks and also enables new tasks to be performed. See also Digitisation. |
| Digitisation | Digitisation is the conversion of an analogue signal conveying information (e.g. sound, image, printed text) to binary bits. Digitisation entails the application of digital technologies to existing tasks. See also Digitalisation. |
| Doctoral Students | Doctoral students attend “tertiary programmes which lead to the award of an advanced research qualification [and which] are therefore devoted to advanced study and original research and are not based on course work only”. Such students are usually required to submit a thesis or dissertation of publishable quality, i.e. the product of original research that represents a significant contribution to knowledge. See also *International Standard Classification of Education*. |
| Early expansion stages of business development | Business development can be summarised as the ideas, initiatives and activities aimed towards making a business better. This includes increasing revenues, growth in terms of business expansion, increasing profitability by building strategic partnerships, and making strategic business decisions. |
| Employees | Employees include all persons who work in or for the statistical unit, who have a contract of employment with the unit and who receive compensation in cash or in kind at regular intervals of time. Employees engaged in activity ancillary to the main activity of the unit are also included, as well as the following groups: persons on short-term leave (sick leave, annual leave or vacation); persons on special paid leave (educational or training leave, maternity or parental leave); persons on strike; and part-time workers, seasonal workers and apprentices when on the payroll. Employees also include persons working physically outside the statistical unit’s premises, when paid by and under the control of the unit (outworkers); for example, outside service engineers and repair and maintenance personnel are employees. |
| Employing enterprises | An enterprise with at least one employee. An Enterprise being the smallest combination of legal units that is an organisational unit producing goods or services, which benefits from a certain degree of autonomy in decision-making, especially for the allocation of its current resources. An enterprise carries out one or more activities at one or more locations. An enterprise may be a sole legal unit. |
| Employment | Employment – See *persons employed.* |
| Enterprise | An enterprise is the smallest combination of legal units with autonomy in respect of financial and investment decision-making, as well as authority and responsibility for allocating resources for the production of goods and services. The term enterprise may refer to a corporation, a quasi-corporation, an NPI or an unincorporated enterprise. It is used throughout this manual to refer specifically to business enterprises. See also Business enterprise sector. |
| Experimental Development | Experimental development is systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes. |
| Fields of Research | The OECD fields of research and development (FoR) classification has been developed in the framework of the Frascati Manualand is used to classify R&D units and resources by fields of enquiry, namely, broad knowledge domains based primarily on the content of the R&D subject matter. |
| Framework conditions | Broader set of contextual factors related to the external environment that facilitate or hinder business activities in a given country. These usually include the regulatory environment, taxation, competition, product and labour markets, institutions, human capital, infrastructure, standards, etc. |
| Full-Time Equivalent (FTE) | FTE is the ratio of working hours actually spent on an activity during a specific reference period (usually a calendar year) divided by the total number of hours conventionally worked in the same period. |
| Global value chains | Pattern of organisation of production involving international trade and investment flows whereby the different stages of the production process are located across different countries. |
| Globalisation | In broad terms, globalisation refers to the international integration of financing, factor supply, R&D, production, and trade of goods and services. |
| Goods | Goods are physical, produced objects for which a demand exists, over which ownership rights can be established and whose ownership can be transferred from one institutional unit to another by engaging in transactions on markets. See also Products. |
| Government Budget Allocations for R&D (GBARD) | Government budget allocations for R&D (GBARD) encompass all spending allocations met from sources of government revenue foreseen within the budget, such as taxation. Spending allocations by extra-budgetary government entities are only within the scope to the extent that their funds are allocated through the budgetary process. Likewise, R&D financing by public corporations is outside the scope of GBARD statistics, as it is based on funds raised within the market and outside the budgetary process. Only in the exceptional case of budgetary provisions for R&D to be carried out or distributed from public corporations should this be counted as part of GBARD. See also *Socio-economic (SEO) objectives classification.* |
| Government expenditure on R&D (GOVERD) | Government expenditure on R&D (GOVERD) represents the component of GERD incurred by units belonging to the Government sector. It is the measure of expenditures on intramural R&D within the Government sector during a specific reference period. See also *Gross domestic expenditure on R&D (GERD)* and *intramural R&D expenditures*. |
| Government Sector | The Government sector consists of the following groups of resident institutional units:   * All units of central (federal), regional (state) or local (municipal) government, including social security funds, except those units that provide higher education services or fit the description of higher education institutions provided in this manual * All non-market NPIs that are controlled by government units that are not part of the Higher education sector. The sector does not include public corporations, even when all the equity of such corporations is owned by government units.   Public enterprises are included in the Business enterprise sector. |
| Green economy | Economy that aims at reducing environmental risks and ecological scarcities, and that aims for sustainable development without degrading the environment. |
| Gross Domestic Expenditure on R&D (GERD) | Gross domestic expenditure on R&D (GERD) is total intramural expenditure on R&D performed in the national territory during a specific reference period. |
| Headcount (HC) | The headcount (HC) of R&D personnel is defined as the total number of individuals contributing to intramural R&D, at the level of a statistical unit or at an aggregate level, during a specific reference period (usually a calendar year). |
| Hidden Innovation | Hidden innovation is innovation activity that is not captured in current innovation indicators. |
| High growth enterprise | A growth enterprise is a company growing faster than its peers or the broader economy. Although there is no hard-and-fast rules of defining growth, these enterprises generally have increased annual revenues by more than the industry average over a sustained period. A enterprise is not classified as a growth enterprise if revenues or other financial metrics surge for one quarter and relax in subsequent periods. This progress must be demonstrated over several years to legitimise the quality of growth. |
| Higher Education Expenditure on R&D (HERD) | Higher education expenditure on R&D (HERD) represents the component of GERD incurred by units belonging to the Higher education sector. It is the measure of intramural R&D expenditures within the Higher education sector during a specific period. See also *Gross domestic expenditure are R&D (GERD)* and *intramural R&D expenditures*. |
| Higher Education Sector | The higher education sector comprises all universities, colleges of technology and other institutions providing formal tertiary education programmes, whatever their source of finance or legal status, and all research institutes, centres, experimental stations and clinics that have their R&D activities under the direct control of, or are administered by, tertiary education institutions. |
| Households | Households are institutional units consisting of one or more individuals. In the SNA, individuals must belong to only one household. The principal functions of households are to supply labour, to undertake final consumption and, as entrepreneurs, to produce market goods and services. |
| Human capital | The skills, knowledge, and experience possessed by an individual or population, viewed in terms of value or cost to an organisation or country. |
| Implementation | Implementation refers to the point in time when a significantly different new or improved product or business process is first made available for use. In the case of product innovation, this refers to its market introduction, while for business process innovations it relates to their first use within the business. |
| Indicator | An indicator is a variable that purports to represent the performance of different units along some dimension. Its value is generated through a process that simplifies raw data about complex phenomena in order to compare similar units of analysis across time or location. See also Innovation indicator. |
| Industry | An economic activity or industry consists of a group of establishments engaged in the same, or similar, kinds of activity. The International Standard Industrial Classification (ISIC) is the reference classification for economic activities. See also ‘International Standard Industrial Classification (ISIC’). |
| Innovation | An innovation is a new or improved product or process (or combination thereof) that differs significantly from the unit’s previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process). |
| Innovation activities | Institutional units can undertake a series of actions with the intention to develop innovations. This can require dedicated resources and engagement in specific activities, including policies, processes and procedures. See also Innovation activities (business). |
| Innovation barriers | Internal or external factors that hamper business innovation efforts. |
| Innovation drivers | Internal or external factors that incentivise business innovation efforts. |
| Innovation indicator | An innovation indicator is a statistical summary measure of an innovation phenomenon (activity, output, expenditure, etc.) observed in a population or a sample thereof for a specified time or place. Indicators are usually corrected (or standardised) to permit comparisons across units that differ in size or other characteristics. See also indicator. |
| Innovation outcomes | Innovation outcomes are the observed effects of innovations, including the extent to which a business’s objectives are met and the broader effects of innovation on other organisations, the economy, society, and the environment. These can also include unexpected effects that were not identified among the business’s initial objectives (e.g. spill overs and other externalities). |
| Innovation project | An innovation project is a set of activities that are organised and managed for a specific purpose and with their own objectives, resources and expected outcomes. Information on innovation projects can complement other qualitative and quantitative data on innovation activities. |
| Innovation status | The innovation status of a business is defined on the basis of its engagement in innovation activities and its introduction of one or more innovations over the reference period of a data collection exercise. See also Innovation-active business and non-innovation-active business |
| Innovation-active business | An innovation-active business is engaged at some time during the reference period in one or more activities to develop or implement new or improved products or business processes for an intended use. Both innovative and non-innovative businesses can be innovation-active during a reference period. See also Innovation status. |
| Internet of things | The interconnection via the Internet of computing devices embedded in everyday objects, enabling them to send and receive data. |
| Intangible assets | See Knowledge-based capital.  Intangible assets consists of assets that lack physical substance in contrast to physical assets (such as machinery, land and buildings) and financial assets (such as government securities). IP, goodwill, and brand recognition are all examples of intellectual assets. |
| Intellectual property products | Intellectual property products are the result of research, development, investigation or innovation leading to knowledge that the developers can market or use to their own benefit in production because use of the knowledge is restricted by means of legal or other protection. Examples include:   * research and experimental development (R&D) * mineral exploration and evaluation * computer software and databases * entertainment, literary and artistic originals. |
| Intellectual property rights (IPRs) | Intellectual property rights (IPRs) are legal rights over intellectual property. See also Intellectual property products. |
| International Organisations | International organisations have as members either national states or other international organisations whose members are national states. They are established by formal political agreements between their members that have the status of international treaties; their existence is recognised by law in their member countries, and they are not subject to the laws or regulations of the country, or countries, in which they are located. For example, they cannot be compelled by national authorities to provide statistical information on their R&D performance or funding activities. For the purposes of the SNA and also for R&D statistics, international organisations are treated as units that are resident abroad (part of Rest of the world), regardless of the physical location of their premises or operations. |
| International Standard Classification of Occupations (ISCO) | The ISCO is used to classify jobs. For the purpose of ISCO, a job is defined as a set of tasks and duties performed, or meant to be performed, by one person, including for an employer or in self-employment. An occupation is defined as a set of jobs whose main tasks and duties are characterised by a high degree of similarity. A person may be associated with an occupation through the main job currently held, a second job or a job previously held. Jobs are classified by occupation with respect to the type of work performed, or to be performed. The basic criteria used to define the system of major, sub-major, minor and unit groups are the “skill level” and “skill specialisation” required to perform the tasks and duties of the occupations competently. |
| International Standard Industrial Classification of All Economic Activities (ISIC) | The International Standard Industrial Classification of All Economic Activities (ISIC) consists of a coherent and consistent classification structure of economic activities based on a set of internationally agreed concepts, definitions, principles and classification rules. It provides a comprehensive framework within which economic data can be collected and reported in a format that is designed for purposes of economic analysis, decision-taking and policy-making. The classification structure represents a standard format to organise detailed information about the state of an economy according to economic principles and perceptions. The scope of ISIC in general covers productive activities, i.e. economic activities within the production boundary of the System of National Accounts (SNA).  The classification is used to classify statistical units, such as establishments or enterprises, according to the economic activity in which they mainly engage. The most recent version is ISIC Revision 4. |
| Knowledge flows | Knowledge flows refer to inbound and outbound exchanges of knowledge, through market transactions as well as non-market means. Knowledge flows encompass both deliberate and accidental transmission of knowledge. |
| Knowledge-based capital (KBC) | Knowledge-based capital comprises intangible assets that create future benefits. It comprises software and databases, Intellectual property products, and economic competencies (including brand equity, business-specific human capital, organisational capital). Software, databases and Intellectual property products are currently recognised by the SNA as produced assets. See also Intellectual property products. |
| Labour productivity | Labour productivity is the rate of output per worker (or group of workers) per unit of time as compared with an established standard of expected rate of output. |
| Labour utilisation | Labour utilisation is the measure of the labour hours recorded against production activities vs. the hours available or scheduled for a given period. |
| Land and buildings | Land and buildings include land acquired for R&D use (e.g. testing grounds, sites for laboratories and pilot plants) and buildings constructed or purchased for R&D use, including major improvements, modifications and repairs. Since buildings are produced assets and land is a non-produced asset in National Accounts, R&D expenditures for land and for buildings should be separately identified. |
| Managerial capability | Managerial capability include all of a business’s internal abilities, capacities, and competences that can be used to mobilise, command and exploit resources in order to meet the business’s strategic goals. These capabilities typically relate to managing people; intangible, physical and financial capital; and knowledge. Capabilities concern both internal processes and external relations. Managerial capabilities are a specific subset of organisational capabilities that relate to the ability of managers to organise change. |
| Marketing innovation | Type of innovations used in the previous edition of this Manual, currently these are mostly subsumed under business process innovation, except for innovations in product design which are included under product innovation. |
| Metadata | Metadata are data that define and describe other data. This includes including information on the procedure used to collect data, sampling methods, procedures for dealing with non-response, and quality indicators. |
| Migrants | A person who moves from one place to another, especially in order to find work or better living conditions |
| Multifactor productivity | Multifactor productivity (MFP) reflects the overall efficiency with which labour and capital inputs are used together in the production process. Changes in MFP reflect the effects of changes in management practices, brand names, organizational change, general knowledge, network effects, spillovers from production factors, adjustment costs, economies of scale, the effects of imperfect competition and measurement errors. Growth in MFP is measured as a residual, i.e. that part of GDP growth that cannot be explained by changes in labour and capital inputs. In simple terms therefore, if labour and capital inputs remained unchanged between two periods, any changes in output would reflect changes in MFP. This indicator is measured as an index and in annual growth rates. |
| New-to-business innovation | Lowest threshold for innovation in terms of novelty referring to a first time use or implementation by a business. A new-to-business innovation can also be new-to-market (or world), but not vice versa. If an innovation is new-to-business but not new-to-market (e.g. when adopting existing products or business processes – as long as they differ significantly from what the business offered or used previously – with little or no modification), it is referred to as “new-to-business only”. See also New-to-market innovation. |
| New-to-market innovation | An innovation by a business that has not been available in the market(s) served by the business. New-to-market innovation represent a higher threshold for innovation than a new-to-business innovation in terms of novelty. See also New-to-business innovation. |
| Non-innovation active business | A non-innovation active business is one that does not report an innovation within the reference period. A non-innovative active business can still be innovation-active if it had one or more ongoing, suspended, abandoned or completed innovation activities that did not result in an innovation during the reference period. See also Innovation-active business and innovation status. |
| Non-profit entity | Non-profit entity are legal or social entities created for the purpose of producing goods and services, whose status does not permit them to be a source of income, profit or other financial gain for the units that establish, control or finance them. They can be engaged in market or non-market production. |
| Novelty | Novelty is a dimension used to assess whether a product or business process is “significantly different” from previous ones and if so, it could be considered an innovation. The first and most widely used approach to determine the novelty of a business’s innovations is to compare these with the state of the art in the market or industry in which the business operates. The second option is to assess the potential for an innovation to transform (or create) a market, which can provide a possible indicator for the incidence of radical or disruptive innovation. A final option for product innovations is to measure the observed change in sales over the reference period or by asking directly about future expectations of the effect of these innovations on competitiveness. |
| Organisational innovation | Type of innovation used in the previous edition of this Manual, currently subsumed under business process innovation. |
| Patent | A government authority or licence conferring a right or title for a set period, especially the sole right to exclude others from making, using or selling an invention. |
| Persons Employed | Persons employed include both employees and unpaid family workers and working proprietors (i.e. active business partners). Silent or inactive partners whose principal activity is conducted outside of the statistical unit should be excluded. See also *internal R&D personnel.* |
| PhD | A Doctor of Philosophy (PhD, Ph.D., or DPhil; Latin philosophiae doctor or doctor philosophiae) is the highest university degree that is conferred after a course of study by universities in most countries. PhDs are awarded for programs across the whole breadth of academic fields. As an earned research degree, those studying for a PhD are usually required to produce original research that expands the boundaries of knowledge, normally in the form of a thesis or dissertation, and defend their work against experts in the field. The completion of a PhD is often a requirement for employment as a university professor, researcher, or scientist in many fields. |
| Physical capital | Physical capital is one of what economists call the three main factors or production. It consists of tangible, man-made goods that assist in the process of creating a product or service. The machinery, buildings, office or warehouse supplies, vehicles, and computers that a company owns are all considered part of its physical capital. |
| Plant breeders’ rights | Plant breeder’s rights (PBR) are used to protect new varieties of plants that are distinct, uniform and stable. PBR are exclusive commercial rights for a registered variety of plant. The rights are form of IP, like patents, trademarks and designs. If you develop a new plant variety, you may want to protect your IP with plant breeders’ rights. The PBR scheme protects plant breeders and gives them a commercial monopoly for a period of time. This encourages plant breeding and innovation, and means that a large and growing pool of new plant varieties is freely available to anybody when the protection periods lapse. |
| Policy relevance | Policy relevance refers to how effectively research findings inform decisions made by decision-makers. In other words, policy relevance is determined by how applicable and practical research findings are to decisions that need to be made on policy priorities. |
| Procurement | The action of obtaining or procuring something. |
| Product | A product is a good or service (including knowledge-capturing products as well as combinations of goods and services) that results from a process of production. See also Goods and Services. |
| Product innovation | A product innovation is a new or improved good or service that differs significantly from the business’s previous goods or services and that has been introduced on the market. Product innovations must provide significant improvements to one or more characteristics or performance specifications. See also Product. |
| Productivity | A measure of the efficiency of a person, machine, factory, system, etc., in converting inputs into useful outputs. Productivity is computed by dividing average output per period by the total costs incurred or resources (capital, energy, material, personnel) consumed in that period. Productivity is a critical determinant of cost efficiency. |
| Public sector | The public sector includes all institutions controlled by government, including public business enterprises. The latter should not be confused with publicly listed (and traded) corporations. The public sector is a broader concept than the General government sector. |
| Purchasers' Prices | Purchasers’ prices are the amounts paid by the purchasers, excluding the deductible part of value-added taxes and similar taxes. Purchasers’ prices reflect the actual costs to the users. This means that the valuation of current and capital expenditures on goods and services for R&D is the total price paid by the reporting unit, including any taxes on products, which act to increase the price paid, and the price-reducing effect of any subsidies on the products purchased. |
| R&D | Research and development |
| R&D Personnel | R&D personnel in a statistical unit include all persons engaged directly in R&D, whether employed by the statistical unit or external contributors fully integrated into the statistical unit’s R&D activities, as well as those providing direct services for the R&D activities (such as R&D managers, administrators, technicians and clerical staff). See also ‘internal R&D personnel’ and ‘external R&D personnel’. |
| Reference period | The reference period is the final year of the overall survey reference period and is used as the effective reference period for collecting interval level data items, such as expenditures or the number of employed persons. |
| Regulation | Regulation refers to the implementation of rules by public authorities and governmental bodies to influence market activity and the behaviour of private actors in the economy. A wide variety of regulations can affect the innovation activities of businesss, industries and economies. |
| Regulatory barriers | Legal or regulatory barriers include agreements, contracts, patents, trademarks, copyrights and/or regulatory protection. Vendors should clearly define the protection and the extent of the protection. |
| Relational Database | A relational database is a type of database that stores and provides access to data points that are related to one another. In a relational database, each row in the table is a record with a unique ID called the *key.* The columns of the table hold attributes of the data, and each record usually has a value for each attribute, making it easy to establish the relationships among data points. |
| Reliability and precision | A metric should be based upon stable and consistent data collection processes across collection points and over time. Progress toward performance targets should reflect real changes rather than variations in data collection approaches or methods. Source data should be clearly identified and readily available from manual, automated or other systems and records. |
| Research and Experimental Development (R&D) | Research and experimental development (R&D) comprise creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge. |
| Researchers | Researchers are professionals engaged in the conception or creation of new knowledge. They conduct research and improve or develop concepts, theories, models, techniques instrumentation, software or operational methods. |
| Satellite account | Satellite accounts are not part of the National Accounts, which are produced according to the SNA. They are closely linked to the main system but are not bound to employ exactly the same concepts or restrict themselves to data expressed in monetary terms. They are used to meet the needs of a particular country or countries where the international community as a whole has not agreed to include them in the SNA. |
| Seed | Start-ups at this level have already validated their value proposition. They have monthly revenue which is consistent, constant and the business is growing month on month. The start-up needs its next level of funding to find true product/market fir, scale, grow and become a competitor in the current market place. |
| Services | Services are the result of a production activity that changes the conditions of the consuming units, or facilitates the exchange of products or financial assets. They cannot be traded separately from their production. Services can also include some knowledge-capturing products. See also Products. |
| Socio-Economic Objectives (SEO) Classification | A socio-economic objectives (SEO) classification is used to distribute GBARD. The criteria for classification should be the purpose of the R&D programme or project, i.e. its primary objective. The allocation of R&D budgets to socio-economic objectives should be at the level that most accurately reflects the funder’s objective(s). The recommended distribution list is based on the European Union classification adopted by Eurostat for the Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets (NA BS) at the one-digit level. See also ‘Government budget allocations for R&D (GBARD)’. |
| Software | A software development project is classified as R&D if its completion is dependent on a scientific and/or technological advance, and the aim of the project is the systematic resolution of a scientific and/or technological uncertainty. In addition to the software that is part of an overall R&D project, the R&D associated with software as an end product or software embedded in an end product could also be classified as R&D when the R&D criteria apply. Software development is an integral part of many projects that in themselves have no element of R&D. The software development component of such projects, however, may be classified as R&D if it leads to an advance in the area of computer software. An upgrade, addition or change to an existing program or system may be classified as R&D if it embodies scientific and/or technological advances that result in an increase in the stock of knowledge. Software-related activities of a routine nature are not to be considered R&D. |
| Start-up | A start-up is a company or project initiated by an entrepreneur to seek, effectively develop, and validate a scalable business model. The concepts of start-ups and entrepreneurship are similar. However, entrepreneurship refers all new businesses, including self-employment and businesses that never intend to grow big or become registered, while start-ups refer to new businesses that intend to grow beyond the solo founder, have employees, and intend to grow large. Start-ups face high uncertainty, and do have high rates of failure, but the minority that go to be successful companies have the potential to become large and influential. Some start-ups become unicorns, i.e. privately held start-up companies valued at over US$1 billion. |
| Suppliers | Suppliers are businesses or organisations that supply goods (equipment, materials, software, components etc.) or services (consulting, business services, etc.) to other businesses or organisations. This includes providers of knowledge capturing products such as IP rights. |
| Survey frame | The frame population is the set of target population members that has a chance to be selected into the survey sample. |
| System of National Accounts (SNA) | The SNA is a statistical framework that provides a comprehensive, consistent and flexible set of macroeconomic accounts for policymaking, analysis and research purposes. The most recent version is the 2008 SNA. |
| Tangible assets | A tangible asset is an asset that has a finite monetary value and usually a physical form. Tangible assets can typically always be transacted for some monetary value through the liquidity of different markets will vary. Tangible assets are the opposite of intangible assets which have a theorized value rather than a transactional exchange value. |
| Tax Credit | A tax credit is an amount subtracted directly from the tax liability due by the beneficiary household or corporation after the liability has been computed. |
| Technology | Technology refers to the state of knowledge on how to convert resources into outputs. This includes the practical use and application to business processes or products of technical methods, systems, devices, skills and practices. |
| Tertiary education | Tertiary education includes what is commonly understood as academic education but also includes advanced vocational or professional education. It comprises ISCED levels 5, 6, 7 and 8, which are labelled as short-cycle tertiary education, Bachelor’s or equivalent level, Master’s or equivalent level, and doctoral or equivalent level, respectively. |
| Timeliness | The measure of timeliness is the delay between the end of the reference period to which the information pertains, and the date on which the information becomes available. Timeliness is typically involved in a trade-off against accuracy. The timeliness of information will influence its relevance. |
| Trademark | A symbol, word, or words legally registered or established by use as representing a company or product. |
| Training | Training includes all activities that are paid for or subsidised by the business to develop knowledge and skills required for the specific trade, occupation or vocation of a business’s employees. Training includes on-the-job training and job-related education at training and educational institutions. Examples of training as an innovation activity include training personnel to use innovations, such as new software logistical systems or new equipment; and training relevant to the implementation of an innovation, such as instructing marketing personnel or customers on the features of a product innovation. |
| Transactional data | Transactional data documents an exchange, agreement or transfer that occurs between organisations or individuals or both, such as purchases and payments. |
| Users innovation | Users innovation refers to activities whereby consumers or end-users modify a business’s products, with or without the business’s consent, or when users develop entirely new products. |
| Value creation | The existence of opportunity costs implies the likely intention to pursue some form of value creation (or value preservation) by the actors responsible for an innovation activity. Value is therefore an implicit goal of innovation, but cannot be guaranteed on an ex ante basis. The realisation of the value of an innovation is uncertain and can only be fully assessed sometime after its implementation. The value of an innovation can also evolve over time and provide different types of benefits to different stakeholders. |
| Venture capital | Capital invested in a project in which there is a substantial element of risk, typically a new or expanding business. |

# Abbreviations

| Abbreviations | Meaning |
| --- | --- |
| ABN | Australian Business Number |
| ABS | Australian Bureau of Statistics |
| ABSBR | Australian Bureau of Statistics Business Register |
| ACCC | Australian Competition and Consumer Commission |
| ACN | Australian Company Number |
| AI | Artificial intelligence |
| AIS Monitor | Australian Innovation System Monitor |
| AISR | Australian Innovation Systems Report |
| ANSTO | Australian Nuclear Science and Technology Organisation |
| ANZSCO | Australian and New Zealand Standard Classification of Occupations |
| ANZSIC | Australian and New Zealand Standard Industrial Classification |
| ANZSRC | Australian and New Zealand Standard Research Classification |
| APS | Adult Population Survey |
| ARC | Australian Research Council |
| ARTG | Australian Register of Therapeutic Goods |
| ATO | Australian Taxation Office |
| ATSE | Australian Academy of Technology and Engineering |
| AUTM | Association of University Technology Managers |
| BCS | Business Characteristics Survey |
| BEA | (US) Bureau of Economic Analysis |
| BEIS | (NZ) Department of Business, Energy and Industrial Strategy |
| BERD | Businesses Expenditure on Research and Development |
| BLADE | Business Longitudinal Analysis Data Environment |
| BLS | Bureau of Labor Statistics |
| BUIT | Business Use of Information Technology |
| CABEE | Counts of Australian Businesses, including Entries and Exits |
| CEO | Chief Executive Officer |
| CIS | Community Innovation Survey |
| CRC | Cooperative Research Centre |
| CRM | Customer relationship management |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| CTS | Consolidated Tariff Schedules |
| CURF | Confidentialised Unit Record File |
| DESSFB | (Australian) Department of Employment, Skills, Small and Family Business |
| DET | (Australian) Department of Education and Training |
| DIIS | (Australian) Department of Industry, Innovation and Science |
| DIPA | Data Integration Partnership for Australia |
| DITCRD | (Australian) Department of Infrastructure, Transport, Cities and Regional Development |
| DOCA | (Australian) Department of Communications and the Arts |
| DOI | Digital object identifier |
| EAAG | OECD Entrepreneurship At A Glance |
| EAS | Economic Activity Survey |
| EDAN | Economic Data and Analysis Network |
| EFCs | Entrepreneurial Framework Conditions |
| EFI | Commission of Experts for Research and Innovation |
| EIS | European Innovation Scoreboard |
| EP | Entrepreneurs’ Programme |
| ERP | Enterprise resource planning |
| ESS | European Statistical System |
| EUR | Euro |
| FoR | Field of Research |
| FTE | Full-time equivalent |
| GBARD | Government Budget Allocation for Research and Development |
| GCR | Global Competitiveness Report |
| GDP | Gross Domestic Product |
| GEM | Global Entrepreneurship Monitor |
| GERD | Gross Expenditure on Research and Development |
| GII | Global Innovation Index |
| GOVERD | Government Expenditure on Research and Development |
| GST | Goods and Services Tax |
| GTARD | Government Tax Relief for Research and Development Expenditure |
| HC | Headcount |
| HDI | Human Development Index |
| HEFP | Higher Education Finance Publication |
| HERD | Higher Education Expenditure on Research and Development |
| HERDC | Higher Education Research Data Collection |
| HR | Human Resources |
| IAS | Internet Activity Survey |
| IATA | International Air Transport Association |
| IC | Innovation Connections |
| ICT | Information and Communication Technology |
| IDB | Integrated Data Base |
| IEA | International Energy Agency |
| IHME | (US) Institute for Health Metrics and Evaluation |
| ILO | International Labour Organization |
| IMF | International Monetary Fund |
| IMR | Innovation Metrics Review |
| INSEAD | Institut European d’Administration des Affairs |
| IP | Intellectual Property |
| IPA | IP Australia |
| IPGOD | Intellectual Property Government Open Data |
| IPLORD | IP Australia’s Intellectual Property Longitudinal Research Data |
| IPR | Intellectual property rights |
| IPU | Inter-Parliamentary Union |
| ISA | Innovation and Science Australia |
| ISCED | International Standard Classification of Education |
| ISCO | International Standard Classification of Occupations |
| ISIC | International Standard Industrial Classification |
| IT | Information Technology |
| ITU | International Telecommunication Union |
| ITUC | International Trade Union Confederation |
| KBC | Knowledge-based capital |
| KCA | Knowledge Commercialisation Australia |
| LLEED | Longitudinal Linked Employer-Employee Database |
| LMIP | Labour Market Information Portal |
| LSPE | Later Stage Private Equity |
| MBIE | (NZ) Ministry of Business, Innovation and Employment |
| MCM | Management Capabilities Module |
| MCS | Management Capability Survey |
| MFP | Multifactor productivity |
| MP | Member of Parliament |
| MSTI | Main Science and Technology Indicators |
| MYEFO | Mid-year Economic and Fiscal Outlook |
| NAIF | Northern Australia Infrastructure Facility |
| NCSES | (US) National Center for Science and Engineering Statistics |
| NCVER | (Australian) National Centre for Vocational Education Research |
| NES | (Global Entrepreneurship Monitor) National Expert Survey |
| Nesta | An innovation foundation and independent charity. Formerly (UK) National Endowment for Science, Technology and the Arts. |
| NESTI | (OECD) National Experts on Science and Technology Indicators |
| NHMRC | Australian National Health and Medical Research Council |
| NIST | Australian National Institute of Standards and Technology |
| NOPSEMA | Australian National Offshore Petroleum Safety and Environmental Management Authority |
| NPI | Non-profit institutions |
| NSB | (Australian) National Science Board |
| NSF | (Australian) National Science Foundation |
| NSO | National statistical office |
| NSRC | (Australian) National Survey of Research Commercialisation |
| NSW | New South Wales |
| NZ | New Zealand |
| OECD | Organisation for Economic Cooperation and Development |
| OISA | Office of Innovation and Science Australia |
| PBR | Plant breeders’ rights |
| PCT | Patent Cooperation Treaty |
| PFRO | Publicly funded research organisations |
| PhD | Doctor of Philosophy |
| PIAAC | Programme for the International Assessment of Adult Competencies |
| PISA | Programme of International Student Assessment |
| PMR | Product Market Regulation |
| PNPERD | Private Non-Profit Expenditure on Research and Development |
| PPP | Purchasing Power Parities |
| QILT | Quality Indicators for Learning and Teaching |
| R&D | Research and Development |
| RD&D | Research, Development and Demonstration |
| RDTI | Research and Development Tax Incentive |
| RKR | Record Keeping Rule |
| RRDC | Rural R&D Corporations |
| S&P | Standard and Poor’s Sovereign Rating |
| SDBS | Structural and demographic business statistics |
| SEO | Socio-Economic Objective |
| SHWAU | Social Health and Welfare Analytical Unit |
| SIOs | Services in Operation |
| SISCA | Standard Institutional Sector Classification of Australia |
| SME | Small and Medium Enterprises |
| SNA | System of National Accounts |
| SPE | Societas Privata Europaea |
| SRI | Science, Research and Innovation |
| SRIBT | Science, Research and Innovation Budget Tables |
| STI | Science, Technology and Industry |
| STIS | Science, Technology and Industry Scoreboard |
| TOA | Type of Activity |
| TRAINS | Trade Analysis and Information System |
| UK | United Kingdom |
| UNCTAD | United Nations Conference on Trade and Development |
| UNE | (Australian) University of New England |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UPOV | International Union for the Protection of New Varieties of Plants |
| US | United States of America |
| UTS | University of Technology, Sydney |
| VC | Venture Capital |
| VC&LSPE | Venture Capital and Later Stage Private Equity |
| VET | Vocational Education and Training |
| WEF | World Economic Forum |
| WIPO | World Intellectual Property Organization |
| WTO | World Trade Organization |

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