Issues Paper

Research and Development Inquiry

31 March 2020

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About the South Australian Productivity Commission

The Commission provides the South Australian Government with independent advice on facilitating productivity growth, unlocking new economic opportunities, supporting job creation and removing existing regulatory barriers.

The Premier and Cabinet Circular PC046 sets out the objectives and functions of the Commission; how inquiries are referred to the Commission, undertaken and reported on; and how the Commission and public sector agencies work together.

The Commission was established to assist the government to:

- improve the rate of economic growth and the productivity of the South Australian economy in order to achieve higher living standards for South Australians;
- improve the accessibility, efficiency and quality of services delivered or funded by government;
- improve South Australia's competitiveness for private sector investment;
- reduce the cost of regulation;
- facilitate structural economic changes while minimising the social and economic hardship that may result from those changes;
- take into account the interests of industries, employees, consumers and the community;
- increase employment;
- promote regional development; and
- develop South Australia in a way that is ecologically sustainable.

The Commission is supported by the Office of the South Australian Productivity Commission (OSAPC) which is an attached office of the Department of the Premier and Cabinet. The Chair of the Commission also serves as the Chief Executive of the OSAPC.

For more information on the Commission, including Circular PC046, visit the website at www.sapc.sa.gov.au

Disclosure

The Commissioners have declared to the South Australian Government all personal interests that could have a bearing on current and future work. The Commissioners confirm their belief that they have no personal conflicts in regard to this inquiry.

Terms of Reference

SOUTH AUSTRALIAN PRODUCTIVITY COMMISSION INQUIRY INTO RESEARCH AND DEVELOPMENT

I, Steven Marshall, Premier, hereby request that the South Australian Productivity Commission (the Commission) undertake an inquiry into research and development.

Background

The South Australian Government has the goal of raising South Australia's rate of economic growth.

The relationship between research and development (R&D), innovation and economic growth has attracted considerable attention from economists and policy-makers. An understanding of R&D activity in South Australia and how it translates into economic performance are extremely important to lifting productivity, incomes and employment in the South Australian economy.

Recent statistics suggest that South Australia's share of national R&D activity has been shrinking. According to the ABS:

- Business expenditure on R&D (BERD) has been relatively static in South Australia over the ten years to 2015-16 with SA's share of national BERD falling from a high of 5.8 per cent in 2011-12 to 4.6 per cent in 2015-16
- Higher education expenditure on R&D (HERD) grew more slowly in South Australia than the national average between 2006 and 2016, with SA's share of Australian HERD falling from 7.3 to 6.5 per cent.

Intellectual Property Australia data indicates that the number of patent applications filed in South Australia has fallen 12 per cent between 2011 and 2017.

Terms of Reference

An inquiry by the SA Productivity Commission would examine trends in R&D and the factors which influence the extent to which this R&D translates into growth in South Australia. The key thrust is to understand how the current structure and operation of the state's public and private R&D contributes to long-term productivity gains and economic growth and make recommendations on actions to raise that contribution.

Independent advice on SA's R&D performance and associated policies and recommendations on reforms to lift the State's R&D performance will help to inform development and delivery of the government's Growth State initiative.

The scope of this inquiry includes mining, agribusiness, cyber risk and other areas as appropriate, except health and medical research which is being considered separately. The Commission is to apply insights from that separate stream to inform this inquiry where relevant.

While wide-ranging data on R&D and innovation is available nationally, comparatively little data is available at the state level. The Commission is to work with government agencies, universities, research institutions and industry to develop indicators and data sets which can be used to monitor and explain the state's performance and inform government policy.

South Australia's Chief Scientist and the Department of Innovation and Skills have been charged with developing strategies to lift innovation performance. The Commission is to have regard to this work where relevant to this inquiry.

The inquiry would examine: the role and settings of policy levers available to the state government; the effectiveness of various government interventions aiming at increasing R&D efficiency and outputs; and recommend actions the government can take (including advice to the Australian Government) on those matters.

Scope

The Commission is asked to consider and report on R&D activity in South Australia: how it translates into economic performance and wellbeing in the State; and recommend actions that the South Australian Government might take in connection with South Australian based R&D to:

1) Increase the output and productivity of South Australian-based publicly funded R&D;
2) Increase South Australian based private sector R&D, and in so doing;
3) Increase the state's:
   a) share of Australian Government funding for research; and
   b) rate of economic growth.

These recommendations are to be based on an evidence-based review of the state's R&D policies, activities and performance including the identification and assessment of:

1) Performance measures
   a) measures of the output and productivity of research activity by (including by key areas of research), and the performance of, publicly funded research institutions in South Australia compared to other jurisdictions.
2) Drivers of output and productivity of SA based R&D
   a) funding
      i) an important task is to identify the extent of funding for research in South Australia (public and private, state and federal, national and international), by source and area of application, as well as forms of expenditure (e.g. capital and operating).
   b) other key factors including
      i) talent pools and the capacity to attract new talent
      ii) industry structure and composition
      iii) hard infrastructure
      iv) the demography of the state
      v) access to data and efficiency of collection and acquisition and other relevant matters, in the context of the changes in the technology of research methods
      vi) national R&D and innovation policies and programs.
3) Current and prospective collaborations
   a) existing collaboration on research between research organisations (public and private) and linkages between those organisations and industry, as well as new models for collaboration.
4) Current and prospective industry engagement
   a) demand for, and current barriers to undertaking, research in cooperation with industry in South Australia and new models to improve industry experience and drive private sector research.

In its consideration of the above matters, the Commission is expected to have regard to the South Australian Government's Growth State initiative and relevant state and national policies including their performance.

Inquiry Process

The Commission will consult with the SA Chief Scientist, SA agencies, universities, research institutions, industry, relevant peak bodies and other key stakeholders during the inquiry.

The Commission may second and/or engage staff with required analytical expertise and knowledge of R&D for the period of the inquiry.

The Commission is to issue an issues paper at the beginning of the inquiry process and to issue a draft report outlining recommendations for consultative purposes. A final report is to be provided to me as soon as possible, but not later than eleven months after receipt of these terms of reference.

Hon Steven Marshall MP

PREMIER OF SOUTH AUSTRALIA

3 / 2 / 2020

Contents

Acronyms and definitions

ABS	Australian Bureau of Statistics
ACAIR	Australian Centre for International Agricultural Research
ACL	Australian Consumer Law
ACSIL	ANZAC Combat System Integration Laboratory
AEC	Animal Ethics Committee
ANZSIC	Australian and New Zealand Standard Industrial Classification
ARC	Australian Research Council
ARENA	Australian Renewable Energy Agency
ATO	Australian Taxation Office
AWQC	Australian Water Quality Centre
AWRI	Australian Wine Research Institute
BERD	Business Expenditure on R&D
CCA	*Competition and Consumer Act 2010*
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAMA	Designated Area Migration Agreement
DEW	Department for Environment and Water
DIS	Department for Innovation and Skills
DPC	Department of the Premier and Cabinet
DST	Department for Defence, Science and Technology
DTI	Department for Trade and Investment
EPA	Environment Protection Authority
FIRB	Foreign Investment Review Board
FTA	Free Trade Agreement
GERD	Gross Expenditure on R&D
GMO	Genetically Modified Organism
GSSA	Geological Survey of South Australia
HERD	Higher Education Expenditure on R&D
HES	Higher Education Standards
ICT	Information and Communications Technology

IP	Intellectual Property
MFP	Multifactor Productivity
NISA	National Innovation and Science Agenda
NCGP	National Competitive Grants Program
OECD	Organisation for Economic Co-operation and Development
OSAPC	Office of the South Australian Productivity Commission
PIRSA	Primary Industries and Regions South Australia
PYE	Person Years of Effort
R&D	Research and Development
SA	South Australia
SAGS	South Australian Geological Survey
SAHMRI	South Australian Health and Medical Research Institute
SARDI	South Australian Research and Development Institute
SARIG	South Australian Resources Information Gateway
STEM	Science, Technology, Engineering and Mathematics
TEQSA	Tertiary Education Quality and Standards Agency
TMI	Tonsley Manufacturing Innovation Hub
UASL	Underwater Acoustic Scattering Laboratory
WTO	World Trade Organisation

1. Introduction

1.1 Purpose of inquiry

The South Australian Productivity Commission (the Commission) has been asked to examine trends in research and development (R&D) and the factors that influence the extent to which research and development translates into growth in South Australia. The primary task is to:

- understand how the current structure and operation of the state's public and private research and development contributes to long-term growth and productivity gains;
- make recommendations to the South Australian Government on actions to raise that contribution.

To do this task, the Commission will examine the pattern of R&D activity, capacity and opportunity to a level of detail necessary to understand the range of actions available to the SA Government to raise the contribution of R&D to growth and productivity in the state. The scope of the Commission's interest includes all the Science, Technology, Engineering and Mathematics (STEM) fields, other natural sciences social science and the humanities and all sectors of the South Australian economy, except health and medical research (HMR), which is the subject of a separate inquiry. As the health and medical research inquiry will be completed before this inquiry, the Commission expects to incorporate relevant insights from it in the final report of the research and development inquiry.

The Commission will, in doing its independent role, have regard to the South Australian Government's Growth State strategy and relevant state and national policies including their performance.

1.2 Commission's approach

The Commission is required to take a broad perspective in developing advice for the South Australian Government. It must consider the interests of industry, business, consumers and the community, regional South Australia, social-economic implications and ecological sustainability.

The Commission conducts its own independent quantitative and qualitative analysis. It also draws on the experience, evidence and views of all inquiry stakeholders and participants. This input generally comes from meetings, submissions and publications.

This issues paper assists interested parties to participate in the inquiry by highlighting the Commission's initial views of key issues and by raising questions to focus feedback.

The Commission will use the information from stakeholders, consultations and submissions and its own independent research to develop a draft report which will set out the Commission's understanding of the issues, its initial conclusions, draft recommendations and requests for further information. The release of the draft report will trigger a second, focused round of consultation with stakeholders. This step is essential to ensure the Commission's final recommendations have been based on a thorough understanding of the issues and the considered views of stakeholders. The final report completes the inquiry, which the Commission expects will make a significant contribution to government policy.

The Commission has no predetermined views on the matters covered by the inquiry. The Commission's initial understanding of the relevant matters will evolve over the course of the inquiry in the light of input and evidence from stakeholders and participants. The distillation and consideration of all the evidence will be incorporated in the Commission's draft report.

The issues paper is structured as follows. Section 2 provides an overview of the research and development sector in SA. Section 3 sets out the policy and regulatory framework, in which the Australian Government plays a key role. Section 4 examines patterns of expenditure on R&D in SA by the public sector, higher education and the private sector. Section 5 sets out the Commission's initial understanding of key issues for the inquiry, including the measurement of R&D; the drivers of R&D outputs; industry engagement in R&D; collaboration; and possible policy instruments. The issues paper concludes with Section 5 which brings together the information requests made in the preceding sections.

1.3 Inquiry process

Make a submission

The Commission invites submissions on the issues paper by 12 June 2020. Submissions may address any of the issues covered by the paper and the terms of reference.

An electronic submission in Word or PDF format is preferred, along with any supporting documentation containing facts, figures, data or examples:

- through our website facility www.sapc.sa.gov.au; or
- via email at sapc@sa.gov.au; or
- via post at:

  South Australian Productivity Commission
  GPO Box 2343,
  ADELAIDE SA 5001

If you would like to discuss how best to communicate with the Commission, the Office of the SAPC can be contacted at 08 8226 7828.

A draft report will be published in August 2020. The draft report will be the start of a further round of consultation with stakeholders, following which the Commission will consider all feedback received; finalise its views; and submit its final report and recommendations to the Premier by 06 January 2021. The Commission is required to publish the final report within 90 days of providing it to the Premier.

Confidentiality

Transparency is an important part of the Commission's independent process for gathering evidence and other elements of the inquiry process. It provides confidence to stakeholders that their views have been heard and accurately shows to the wider public the breadth of views and information that have been put to the Commission in reaching its independent conclusions and recommendations. To that end the Commission will publish the submissions that it receives on its website unless the author clearly indicates that the submission is confidential or the Commission considers the material to be offensive, potentially defamatory, beyond the scope of the inquiry's terms of reference, or an abuse of process.

Key dates

06 February 2020
Notice of inquiry

31 March 2020
Issues Paper

March through June 2020
Public consultation

12 June 2020
Submissions to issues paper due

August 2020
Draft report

August and September 2020
Draft report public consultation

02 October 2020
Submissions due on draft report

06 January 2021
Final report presented to the Premier

06 April 2021
Due date to be available to the public

If you wish to submit material in confidence, please advise us why your submission should remain confidential and we will contact you to discuss. We reserve the right to decline your submission if we do not agree with the rationale provided for it to be confidential. Material accepted as confidential will be read only by our Commissioners and staff and will not be referred to in our reports. Later, if we consider the confidential information to be important for conclusions drawn by the Commission, we will seek your permission to refer to it in a form that is acceptable to you.

Confidential submissions may be subject to the *Freedom of Information Act 1991* that provides applicants the right, subject to some restrictions, to access documents created and held by the government. Avoid the use of personal or identifying information in submissions, e.g. contact details or names of people referred to in submissions. The Commission will ensure that all personal contact details are removed from submissions before they are published on our website.

2. Overview of R&D in SA

2.1 Background

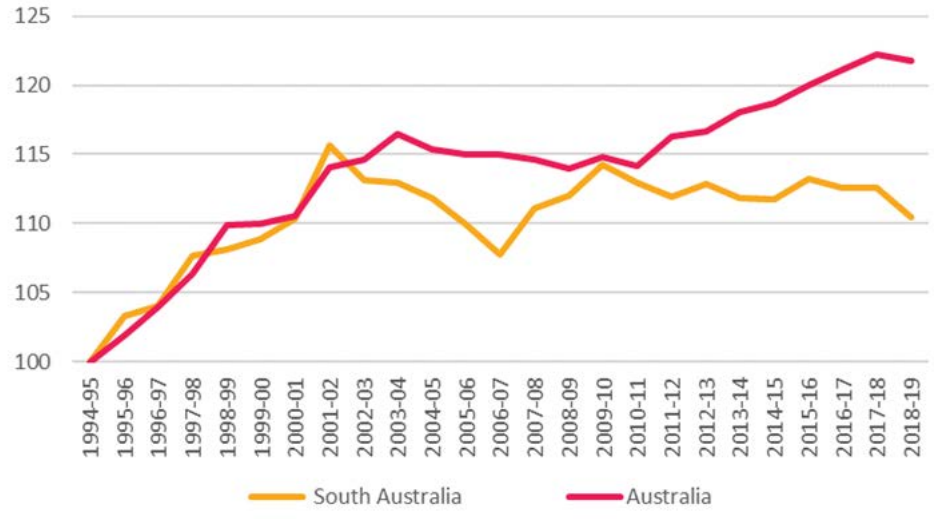
R&D activity is a significant part of the Australian and South Australian economies.

- The Australian and state and territory governments spent more than $3 billion in 2016-17 of which around $430 million (13.2 per cent) was spent in South Australia.
- The higher education sector spent around $11 billion in 2016 of which approximately $700 million (6.5 per cent) was spent in South Australia.
- The private sector spent more than $17 billion in 2016 of which about $800 million (4.6 per cent) was spent in South Australia.

Total spending on R&D by all sectors in South Australia is of the order of nearly $2 billion a year. Research and development is an important activity in the South Australia economy because of its size and its potential contribution to growth, productivity and living standards.

The SA Government has set a target for South Australia's economic growth of 3 per cent per annum, approximately three times the average growth rate for the past decade. South Australia's growth rate has lagged the rest of mainland Australia with its share of national income, employment and population steadily declining.[1] South Australia's multifactor productivity (MFP) has been flat for the past 20 years, as shown in Figure 2.1, and will need to lift significantly to play a part in lifting growth rates. While R&D is not the only factor influencing productivity, a highly-performing research and development sector would be an important contributor to innovation and industries and, as a result, to productivity growth.

Figure 2.1 South Australia's and Australia's MFP growth, index 1994-95 = 100



Source: ABS 5260.0, ABS 5204.0

This is why the Commission has been tasked to recommend to the SA Government what it can do to improve how SA R&D contributes to higher productivity and growth rates.

[1] Joyce Advisory, Review of the South Australian Government's International and Interstate Engagement Bodies and Functions, (2019), pp. 3-15.

2.2 Research and development providers

South Australia's research and development providers are funded and operated by government, predominantly at commonwealth and state level, by higher education institutions, by businesses and by some not-for-profit organisations.

This section sets out the significant providers and briefly describes their role and focus. This list may not be exhaustive or representative of the breadth of providers in the state.

2.2.1 Governments

Tables 2.1 and 2.2 summarise Australian and South Australian government institutions undertaking or involved in research and development in South Australia.

Table 2.1 sets out the Australian Government bodies that undertake R&D in South Australia and either have significant operations in the state or are based in SA. The Commission's interest is in the local operations in SA. There are also Australian Government bodies including rural R&D corporations that fund research in SA.

Table 2.1: Australian Government bodies doing research and development in South Australia

Organisation	Research focus	South Australian activity
CSIRO	The CSIRO has considerable breadth of research expertise across environmental science, farming, health, IT, renewables and climate science, mining and manufacturing.	The CSIRO operates 59 locations across Australia with three of those locations in SA, located in the Adelaide CBD, at South Australian Health and Medical Research Institute (SAHMRI) and at the Waite Research Institute. CSIRO activity at Waite focuses on research into plant breeding, wine and viticulture and sustainable agricultural systems. CSIRO activity at SAHMRI has a focus on nutritional health.
Department for Defence, Science and Technology	The Department for Defence, Science and Technology (DST) is the Australian Government's lead agency responsible for applying science and technology to safeguard defence and national interests. DST operates eight research facilities across Australia, including the Edinburgh facility in Adelaide.	The Edinburgh facility of DST houses the following research capability: • Underwater Acoustic Scattering Laboratory (UASL) • Missile Simulation Centre • Rocket Motor Test Facility • ANZAC (Frigates) Combat System Integration Laboratory (ACSIL) • Australian Submarines' Torpedo System • Defence Experimentation Airborne Platform • Electromagnetic Environmental Effects Test Facility
Other agencies	Including: • Bureau of Meteorology • Wine Australia • Grains Research and Development Corporation	• The Bureau of Meteorology has an Adelaide office • Wine Australia is headquartered in Adelaide • The Grains Research and Development Corporation has an Adelaide office

Source: South Australian Productivity Commission research of Commonwealth documents and sources

Table 2.2: South Australian Government research and development bodies

Organisation	Research focus	South Australian activity
South Australian Research and Development Institute (SARDI)	• Production and profitability of primary industries, food and wine • Sustainable management of natural resources that underpin primary industries production • Protecting and enhancing market access for South Australian businesses and products • Food innovation	SARDI has three metropolitan research centres at the Waite Campus (The Plant Research Centre, the Molecular Diagnostic Centre and the South Australian Aquatic Sciences Centre) and 10 regional research centres. SARDI also identifies and commercialises its intellectual property, through knowledge transfer, licensing or fee for service, to increase industry development. Revenue from intellectual property commercialisation is reinvested in relevant research and development.
Australian Water Quality Centre (AWQC)	Research projects contribute directly to water and wastewater services to provide continuous, high quality supply, protect the health of the public and minimise environmental impacts.	The Centre has laboratory facilities in SA Water House covering microbiology, chemistry services, research services and quality control.
Goyder Institute	Partnership between the Department for Environment and Water, CSIRO, Flinders University, the University of Adelaide, the University of South Australia and The International Centre of Excellence in Water Resources Management.	The institute has operated since 2010 as an independent expert science advisor providing quality, evidence-based knowledge on water management issues important for policy making in South Australia.
Geological Survey	Collect, manage and deliver information and knowledge of SA's geology, particularly for the mineral resources sector. Research and development of digital mapping techniques for SA into databases enabling rapid delivery through the SA Resources Information Gateway (SARIG).	Contributes to South Australian-focused collaborative projects with other state and federal government agencies, universities and research bodies. Maintains a drill core library at the Tonsley facility, including collections and samples for use by researchers.

Source: South Australian Productivity Commission research of Commonwealth documents and sources

2.2.2 Higher education sector

The major higher education institutions active in R&D in South Australia are the University of Adelaide, the University of South Australia (UniSA) and the Flinders University. Table 2.3 summarises the research focus locations of these institutions.

Table 2.3: Higher education research and development providers in South Australia

Organisation	Research focus	Locations
University of Adelaide	The principle foci are: • photonics and advanced sensing • mineral energy and resources • machine learning • agriculture, food and wine • human reproduction and clinical health • material characterisation and fabrication • genetic science and plant genomics	Research precincts at the North Terrace campus, the SA Health and Biomedical Precinct, at the Waite campus and at the Roseworthy campus. The University has numerous specialist research centres working across many industry sectors and is a host and partner of several National Centres of Excellence (hosting the CRCs on high integrity Australian pork and fighting food waste).
University of South Australia	The University of South Australia aims to build research capability positioned around six key themes that respond to some of the most pressing needs of society: • an age-friendly world • transforming industries • cancer prevention and management • scarce resources • healthy futures • society and global transformation	The research themes are interdisciplinary and seed research activities that span existing schools and divisions. Uni SA has research and industry alliances with the Centre for Cancer Biology, the Alliance for Research in Exercise, Nutrition and Activity, the Australian Centre for Asian Business, the Centre for Tourism and Leisure Management and Industrial AI. Uni SA also hosts a Centre of Excellence on Cell Therapy Manufacturing.
Flinders University	Research centres and institutes across all disciplines in the institution's four faculties covering health and medical sciences, engineering and technology, people and society, science, environment and natural resources with defence as a sector of emerging interest. Research also occurs in several specialist research centres and areas of strategic research focus. The university's areas of strategic research focus are flagship collaborative research programs, which are selected competitively to represent Flinders' key research capabilities.	The Tonsley precinct houses health and medical research capability, including the Global Centre for Modern Ageing, the Medical Devices Research Institute and the Flinders Surgical Laboratory. The precinct also contains the Tonsley Manufacturing Innovation (TMI) Hub and the Innovative Manufacturing Cooperative Research Centre and works with local manufacturers to promote the understanding and application of the Australian Government's Industry 4.0 agenda, including robotics and automation.

Source: South Australian Productivity Commission summary of Commonwealth Government documents and sources

2.2.3 Private sector

As detailed in Table 4.4 research and development activity undertaken by business occurs across the state's economy. In particular, 'professional, science and technical services' and the manufacturing sector, inclusive of wine, food, biotech and medical devices, with emerging activity in digital and telecommunications firms.

There are examples of industry-led and industry-financed organisations specifically established to support research and development. They include the Australian Wine Research Institute (AWRI). AWRI is the Australian grape and wine industry's research organisation, is governed by a skills-based board and is a member of the Wine Innovation Cluster located at the Waite Research Precinct in Adelaide. The South Australian Oyster Research Council was established in 1999 to promote, encourage and coordinate research and development for the benefit of the SA oyster industry.

3. Policy and regulatory framework

Several Australian Government and state and territory government agencies regulate business operations; in addition, international agreements also impact the Australian environment. The protection of intellectual property is a key area of government regulation, whose framework is largely set by the Australian Government. Box 3.1 lists the key instruments. Governments at all levels also have policies and programs directed at R&D and innovation.

3.1 Intellectual property law

Intellectual property (IP) and other intangible assets that relate to doing business include patents, trademarks, designs, and secret processes and formulae.

Australian IP law is designed to encourage innovation and protect businesses that develop original IP in order to have a competitive advantage. Australia is also a signatory to a number of international agreements that protect IP in other countries. States and territories have policies relating to their own IP and rules for contracting with businesses in relation to IP. Box 3.1 summaries the elements of Australia's Intellectual Property framework.

Box 3.1: Australian intellectual property protection

Patent protection
An Australian patent provides a legal right to stop third parties from manufacturing, using and/or selling an invention in Australia. It may also be used to license someone else to manufacture an invention on agreed terms. Australian patents are administered by IP Australia.

Trademark protection
Australia has a well-developed legal system that protects the intellectual property of businesses and individuals. Businesses can register a trademark as a marketing tool. A registered trademark provides legal protection that prevents others from using another's brand. Trademarks are issued and protected nationally.

Registering a domain name
A domain name is a unique internet site address that allows others to access a website. Internet addresses ending in '.au' are registered in Australia and are administered and regulated by the .au Domain Administration (auDA).

Design protection
Australia has a statutory framework for the registration of designs. A design application can be filed containing one design, a single design in relation to many products, or multiple designs.

Copyright protection
Australian copyright law is designed to encourage and protect those businesses which invest their time and talent in the creation of new material. Australia is also a signatory to a number of international conventions that deal with copyright. Material is automatically protected by copyright in Australia under the legislative framework. No specific registration is required. There are some exemptions from what is covered and around the use of copyrighted material**.**

Source: Austrade: Understanding Australian Business Regulation https://www.austrade.gov.au/

3.2 Australian business and environment laws

Australian Government and state and territory government legislation exists to protect consumers, the environment and the community, as well as to promote fair trading and competition. These laws govern how businesses interact with their suppliers, customers and other businesses. They also outline the rights of businesses and business owners when conflicts arise. These include:

- a national statutory competition framework to ensure that trading is fair for businesses and consumers that is administered and enforced by the Australian Competition and Consumer Commission (ACCC);
- Australian Consumer Law (ACL) which provides regulations on unfair contract terms, consumer rights guarantees, product safety laws, unsolicited consumer agreements, lay-by agreements and penalties, and other areas;
- a national statutory framework to regulate product safety and information standards;
- jointly administered environmental protection legislation;
- national privacy legislation, overseen by the Office of the Australian Information Commissioner, that regulates how businesses can collect, access, and store personal information and communication;

Australia has strong trade ties with the rest of the world and it has a number of agreements and regulations that effect domestic industries including:

- six free trade agreements with another eight under negotiation;
- commitments to the World Trade Organisation (WTO) on tariffs, tariff quotas, and export subsidies; and
- various other import regulations.

3.3 Australian regulation of universities

The Tertiary Education Quality and Standards Agency (TEQSA) is Australia's single national quality assurance and regulatory agency for higher education.

The standards that are applied are set out in the Higher Education Standards Framework (Threshold Standards) 2015 (the HES Framework). The HES specifically reference the minimum requirements for the conduct of research and recording of research activity by a higher education provider; and additional requirements that must be met if research training is offered.

Higher Education providers who are receiving funding from national Australian funding bodies, such as the Australian Research Council (ARC) or the National Health and Medical Research Council (NHMRC) or other major agencies, must meet stringent requirements attached to their funding that are more detailed than the requirements of the HES Framework, including various codes of conduct.

The Australian Qualifications Framework is the national policy which specifies the nature of qualifications in the education and training sector. This includes postgraduate research degrees, which are important elements of research activity.

3.4 Australian Government R&D and innovation policies and programs

The National Innovation and Science Agenda (NISA) was announced by the Australian Government in December 2015. It sets a focus on science, research and innovation as long-term drivers of economic prosperity, jobs and growth.

The agenda focuses on four key pillars:

- Taking the leap: backing Australian entrepreneurs by opening new sources of finance, embracing risk, taking on innovative ideas, and making more of public research.
- Working together: increasing collaboration between industry and researchers to find solutions to real world problems and to create jobs and growth.
- Best and brightest: developing and attracting world-class talent for future jobs.
- Leading by example: embracing innovation and agility in the way government does business.

Table 3.1 provides a summary of Australian Government investment in R&D. The table shows a total investment of over $9 billion in 2018-19. This includes expenditure on research by its own agencies (intramural) and others (extramural) which includes measures managed through the tax system and funds transferred to Universities and other multisector programs.

Table 3.1: Australian Government investment in R&D by program, by sector, 2018-19

Program	$M
Investment in intramural R&D	
Australian Government research activities	
CSIRO	834.56
Defence Science & Technology (DST) Group	468.75
Australian Government (Other R&D)	769.27
Sub-total	***2,072.58***
Investment in extramural R&D	
Business Enterprise sector	
Industry R&D tax measures	2,059.00
Business (Other R&D)	60.37
Sub-total	***2,119.37***
Higher education sector	
Australian Research Council (ARC)	764.11
NHMRC (University)	630.48
Research block grants	1,921.10
Former funding framework	0.00
Higher education (Other R&D)	239.55
Sub-total	***3,555.24***
Multisector	
NHMRC (Government, MRI, Hospital, Other)	215.71
Other Health	360.59
Cooperative Research Centres (CRCs)	167.34
Rural R&D Corporations	324.79
Other rural R&D	46.96
Energy and the Environment	296.41
Other R&D	213.48
Sub-total	***1,625.27***
Private Non-profit sector	11.17
Rest of the World	12.62
Total R&D investment (current prices)	**9,396.25**

Source: Department of Industry, Innovation and Science, 2018-19 Science, Research and Innovation Budget Tables

3.4.1 Competitive grant funding

The Australian Research Council (ARC) is an Australian Government entity whose purpose is to grow knowledge and innovation for the benefit of the Australian community through funding the highest quality research, assessing the quality, engagement and impact of research and providing advice on research matters. The ARC also advises the government on research matters and administers the National Competitive Grants Program (NCGP).

The Australian Government's Cooperative Research Centres (CRC) Program targets competitiveness and productivity by helping industry to partner with the research sector to solve industry-identified issues. The program provides long term funding for CRCs and funds short-term research collaborations through its CRC-Projects grants.

3.4.2 Innovation connections

The Innovation Connections program[2] assists businesses to specify their research needs, connect with the research sector and fund collaborative research projects in:

- advanced manufacturing;
- food and agribusiness;
- medical technologies and pharmaceuticals;
- mining equipment, technology and services; and
- oil, gas and energy resources.

Businesses that provide enabling technologies and services to those sectors are also eligible.

3.4.3 Research and Development tax incentive

The research and development (R&D) tax incentive is the Australian government's key tax instrument to raise business investment in R&D. The tax incentive encourages business investment in R&D by providing tax offsets for eligible R&D expenditure.

Eligible companies with a turnover of less than $20 million receive a refundable tax offset, allowing the benefit to be paid as a cash refund if they are in a tax loss position. All other eligible companies receive a non-refundable tax offset to help reduce the tax they pay.

Following a report commissioned by the Australian Small Business and Family Enterprise Ombudsman (December 2019), the Australian Taxation Office (ATO) and AusIndustry have revised their approach to R&D tax incentive compliance. Part of the report focussed on how small and medium sized businesses felt that compliance measures discouraged investment in R&D by this sector. It will be difficult to determine the impact of these changes on business investment in R&D.

3.4.4 CSIRO

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) operates under the provisions of the *Science and Industry Research Act 1949* which sets out its functions which include:

- carrying out scientific research for any of the following purposes:
    - assisting Australian industry;
    - furthering the interests of the Australian community;
    - contributing to the achievement of Australian national objectives or the performance of the national and international responsibilities of the Commonwealth; and
    - any other purpose determined by the Minister;
- to encourage or facilitate the application or utilisation of the results of such research.

[2] The Innovation Connections program is included in 'Business (Other R&D)' in Table 3.1.

Its secondary functions include international scientific liaison, training research workers, publishing research results, transferring technology from research, providing scientific services and disseminating information about science and technology.

3.4.5 DST

Defence Science and Technology (DST) is part of Australia's Department of Defence. DST is the Australian Government's lead agency responsible for applying science and technology to safeguard Australia's national interests. It has a presence in most Australian state and territories including SA. It works closely with industry, universities and the scientific community.

3.4.6 NCRIS

The National Collaborative Research Infrastructure Strategy[3] (NCRIS) is a national network of world class research infrastructure projects that support high quality research. It works with the research sector to identify priorities for research infrastructure over the next decade and supports 40,000 domestic and international researchers each year.

3.4.7 NHMRC

The National Health and Medical Research Council (NHMRC) is Australia's peak body for supporting health and medical research, for developing health advice for the community, providing advice on ethical behaviour in health care and in the conduct of health and medical research.

3.4.8 MRFF

The Medical Research Future Fund[4] (MRFF) is a $20 billion long-term fund that supports health and medical research that improves lives, builds the economy and contributes to health system sustainability.

3.5 South Australian Government policies and programs

Historically, the South Australian Governments have developed various strategic policy initiatives and programs to support innovation and R&D investment in the private sector. They include the "Investing in Science Action Plan" (January 2014), and the "STEM Skills Strategy" (2011), with implementation overseen by South Australia's Chief Scientist. During 2019, the Chief Scientist developed a discussion paper 'South Australia The State of Science, Research and Innovation'. The paper identifies a strategy, referred to as EXCITE[5], which aims to contribute to the state government's Growth State plan for economic growth. The Commission has engaged with the Chief Scientist on several occasions in the process of developing this issues paper.

In August 2018, Cabinet approved a framework for industry assistance which established:

- priorities for industry development;
- industry financial assistance principles to guide when direct financial assistance for businesses is appropriate;

[3] The NCRIS is included in 'Other R&D' as a multi-sector R&D program in Table 3.1.
[4] The MRFF is included in 'Other Health' as a multi-sector R&D program in Table 3.1.
[5] Excellence, Collaboration, Innovation and Translation, and an Enabled Future Workforce

- a streamlined set of industry assistance funds; and
- new governance arrangements for decision making.

The Industry Assistance Framework focuses on supporting economic growth. Financial assistance to private sector entities is delivered through three designated funds.

The Economic and Business Growth Fund – designed to support industry and business growth in South Australia through adopting new technologies and improving capability and capacity. This fund of $100 million over four years is managed by the Department of Treasury and Finance.

The Research, Commercialisation and Startup Fund – support for South Australian businesses to collaborate with researchers and universities to solve industrial problems, commercialise new products and services, attract research infrastructure investment into the state; and encourage the establishment and growth of start-ups. This fund of $28 million over four years is managed by the Office of the Chief Entrepreneur, and the Department for Innovation and Skills.

The Regional Growth Fund – to build and strengthen regional South Australian communities to pursue new economic opportunities. This fund of $150 million over 10 years is managed by the Department of Primary Industries and Regions SA.

In addition, the government is responsible for administering ethics applications for research projects, consumer product laws, workplace health and safety legislation as well as legislation on genetically modified organisms.

The South Australian Government also has an Intellectual Property (IP) Policy that applies to IP generated, acquired or held by agencies on behalf of government. Its purpose is to:

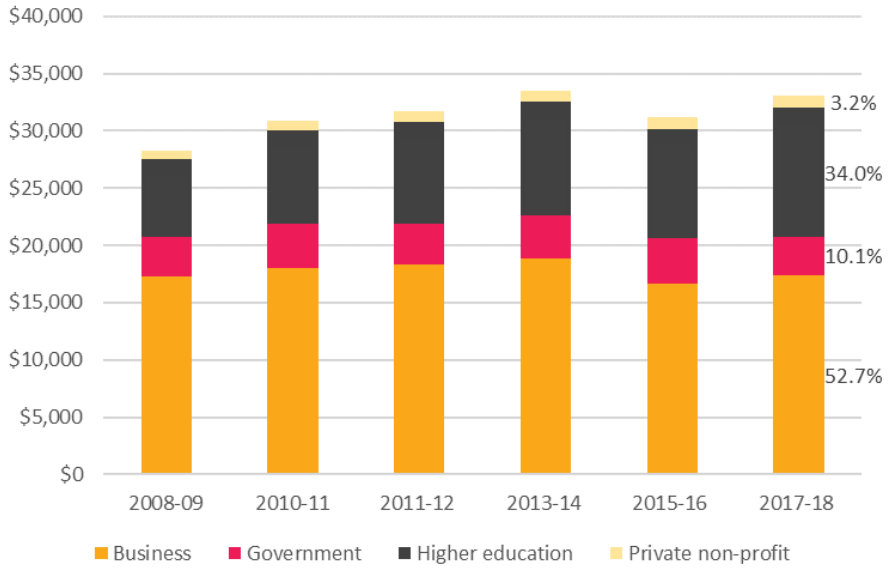
- provide a framework for the use, generation, acquisition and management of IP in government, and
- ensure that government-owned intellectual property is used to generate public value, knowledge transfer and innovation to the fullest extent possible.

The use of IP remains subject to other government policies, procedures and practices as well as relevant legislation. The Commission has not yet identified IP assets with significant commercial or operational value registered by agencies.

4. Expenditure on R&D

Across Australia, business expenditure on R&D (BERD) accounts for over half of national R&D expenditure (52.7 per cent in 2017-18) followed by higher education expenditure on R&D (HERD) (34.0 per cent).

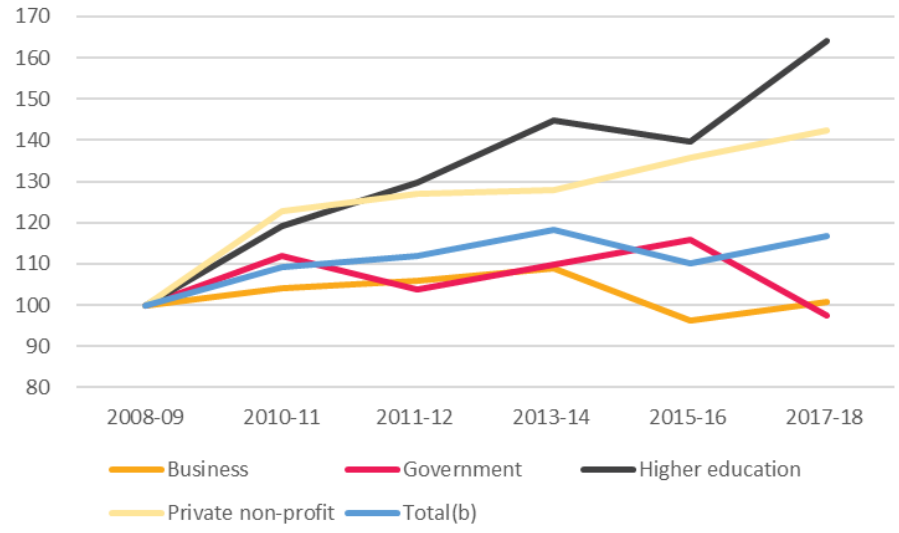
Figure 4.1: Gross expenditure on R&D by sector, Australia ($m)



Source: ABS 8104.0

There are gaps and non-comparability in the data. The ABS does not break down the estimates of gross expenditure on R&D by sector at the state level. In addition, state estimates of BERD, HERD and Government expenditure on R&D cannot be directly compared due to differences in the frequency and timing of collections and because they cover different time periods.

Figure 4.2: Change in R&D expenditure by type, Australia, Index (2008-09 = 100)



Source: ABS 8104.0

Higher education expenditure on R&D has been the fastest growing expenditure category since 2008-09, growing on average 5.7 per cent per annum. Government and business expenditure has changed little over this period. While private non-profit is the second fastest growing expenditure category, it represents only 3.2 per cent of national R&D expenditure and only 2.3 per cent of private non-profit expenditure on R&D occurs in South Australia.

4.1 Government sector

Australian and South Australian Government expenditure on R&D in South Australia totalled $433 million in 2016-17, as shown in Table 4.1, with the South Australian Government spending $103.6 million.

It also shows that in 2016-17 a relatively high share of R&D by government (13.2 per cent) was spent in South Australia. This is the case for both spending by the state (9.1 per cent) and federal government (15.4 per cent), and especially for the latter.

Considering the ratio of the state and federal shares of total spending SA, there appears to be a significant degree of leverage of state spending to federal funding. For every dollar spent by the SA Government, the Australian Government spent $3.18 in South Australia.

Table 4.1: Government expenditure on R&D, by location of expenditure, 2016-17

Location of expenditure	Australian Government ($'000)	Share by state %	State/ territory ($'000)	Share by state %	Total ($'000)	State share of state total %	State share of national total %
New South Wales	351,261	16.4	274,856	24.1	626,117	43.9	19.1
Victoria	529,392	24.8	262,895	23.1	792,287	33.2	24.2
Queensland	243,681	11.4	294,827	25.9	538,508	54.7	16.4
South Australia	329,182	15.4	103,601	9.1	432,783	23.9	13.2
Western Australia	124,554	5.8	145,198	12.7	269,752	53.8	8.2
Tasmania	124,482	5.8	1,313	0.1	125,795	1.0	3.8
Northern Territory	36,554	1.7	42,670	3.7	79,224	53.9	2.4
Australian Capital Territory	367,364	17.2	13,592	1.2	380,956	3.6	11.6
Total expenditure on R&D	2,138,944	100.0	1,139,811	100.0	3,278,755	34.8	100.0

Note: Government in this table does not include universities.
Source: ABS 8109.0

Currently, no details are published about the areas of government expenditure on R&D in South Australia. The Australian Government publishes a detailed breakdown of their expenditure at the national level in their science, research and innovation budget tables.[6] The South Australian Government does not publish estimates of its expenditure on R&D beyond specific funding programs. These gaps in data available limit the ability to analyse

[6] Australian Government, Science, Research and Innovation Budget Tables, (2019), Department of Industry, Science, Energy and Resources.

investments in R&D in South Australia. The Commission will, as a priority, build a greater understanding of this expenditure.

4.2 Higher education sector

The largest sources of funds for R&D by universities in South Australia are general university funds and commonwealth funding for R&D, as demonstrated in Table 4.2.

Table 4.2 Higher education expenditure on R&D, by source of funds, by location, 2016

Source of Funds	SA		Australia		SA share of Australia (%)
	$'000	%	$'000	%	
Australian competitive grants	129,652	18.3	1,672,841	15.4	7.8
General university funds	317,559	44.9	6,075,061	55.8	5.2
Other commonwealth government	152,998	21.6	1,610,147	14.8	9.5
State and local government	34,019	4.8	420,107	3.9	8.1
Business	37,882	5.4	475,982	4.4	8.0
Donations, bequests and foundations	9,881	1.4	250,761	2.3	3.9
Other Australian	0	0.0	314	0.0	0.0
Overseas	25,180	3.6	372,305	3.4	6.8
Total	707,171	100.0	10,877,517	100.0	6.5

Source: ABS 8111.0

Compared to the national total, South Australian universities spend a smaller proportion of general university funds on R&D and are more reliant on Australian Government grant funding. The Commission understands that one of the largest sources of discretionary funds available for universities to spend on R&D is surplus revenue from international student fees. The Commission intends to further understand the role of international students in R&D funding.

Table 4.3 shows South Australia spends a higher proportion of R&D on pure basic research and strategic basic research than the national average. In terms of fields of research, South Australia spends a higher proportion of HERD on information and computer science, chemical science, agricultural and veterinary science, built environment and design, environmental sciences and health and medical sciences.[7]

[7] See table A3.

Table 4.3: Higher education expenditure on R&D, by location, by type of activity, per cent of total, 2016

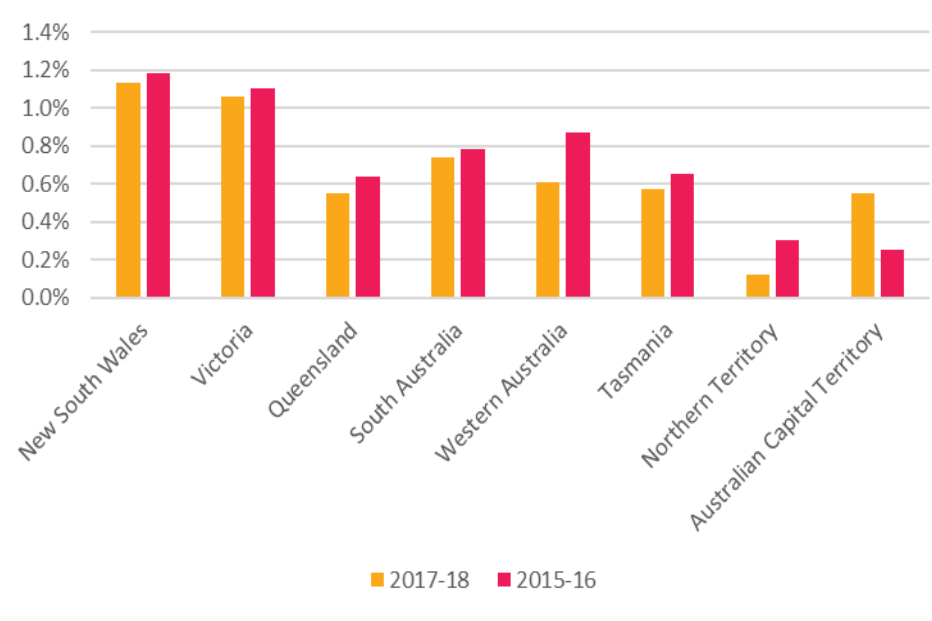
Type of Activity	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	Aust
Pure basic research[8]	25.2	23.8	16.6	**24.0**	19.5	17.8	0.0	32.2	22.8
Strategic basic research[9]	18.2	17.3	18.7	**21.6**	18.0	23.2	5.9	23.8	18.6
Applied research	44.7	52.0	51.3	**46.1**	50.1	54.3	90.9	36.2	48.5
Experimental development	11.9	6.9	13.5	**8.3**	12.4	4.7	3.2	7.8	10.1
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: ABS 8111.0

4.3 Private sector

Nationally, BERD accounts for approximately one per cent of GDP, with a higher proportion of this expenditure occurring in New South Wales and Victoria, as shown in Figure 4.3. In South Australia BERD represents less than 0.8 per cent of GSP.

Figure 4.3: Business expenditure on R&D as a percentage of GSP, by location



Source: ABS 8104.0

The overwhelming majority of BERD is funded by business' own funds (94.9 per cent in 2017-18) with comparably small amounts funded by Australian, state and local governments and overseas. Further detail is presented in Appendix 1.

[8] Pure basic research is defined as research conducted for the advancement of knowledge, without seeking economic or social benefits or making an active effort to apply the results to practical problems or transfer the results to sectors responsible for their application.
[9] Strategic basic research is defined as research conducted with the expectation that it will produce a broad base of knowledge likely to form the basis of the solution to recognised or expected current or future problems or possibilities.

Around 4.6 per cent of national business expenditure on R&D in 2017-18 occurred in South Australia. The largest areas of expenditure in both South Australia and nationally were professional, scientific and technical services (34.5 per cent) and manufacturing (24.7 per cent) as shown in Table 4.4.

Table 4.4: Business expenditure on R&D, [10] by ANZSIC industry subdivision, by location, 2017-18

Industry subdivision	South Australia	Per cent of SA total	Total expenditure on R&D	Per cent of Australia	SA share of National
	$'000	%	$'000	%	%
Agriculture, forestry and fishing	24,381	3.1	313,596	1.8	7.8
Mining	65,226	8.2	1,049,805	6.0	6.2
Manufacturing	197,247	24.7	4,599,464	26.4	4.3
Electricity, gas, water and waste services	25,784	3.2	353,020	2.0	7.3
Construction	N/A[11]	N/A	349,164	2.0	N/A
Wholesale trade	53,254	6.7	930,532	5.3	5.7
Retail trade	10,230	1.3	242,204	1.4	4.2
Accommodation and food services	N/A	N/A	37,838	0.2	N/A
Transport, postal and warehousing	N/A	N/A	120,423	0.7	N/A
Information, media and telecommunications	14,230	1.8	610,052	3.5	2.3
Financial and insurance services	63,441	8.0	2,846,990	16.3	2.2
Rental, hiring and real estate services	25,484	3.2	193,815	1.1	13.1
Professional, scientific and technical services	275,245	34.5	5,113,123	29.3	5.4
Administrative and support services	N/A	N/A	166,800	1.0	N/A
Public administration and safety	N/A	N/A	21,889	0.1	N/A
Education and training	N/A	N/A	50,604	0.3	N/A
Health care and social assistance	14,081	1.8	140,823	0.8	10.0
Arts and recreation services	0	0.0	122,788	0.7	0.0
Other services	18,168	2.3	174,653	1.0	10.4
Total	**797,988**	**100.0**	**17,437,585**	**100.0**	**4.6**

Source: ABS 8104.0

In South Australia the largest shares of BERD in 2017-18 were in the industries of professional, scientific and technical services (34.5 per cent), manufacturing (24.7 per cent), mining (8.2 per cent) and finance and insurance services (8.0 per cent). Compared with the sectoral shares in national BERD in 2017-18, spending in SA was proportionately higher in sectors including agriculture, forestry and fishing (7.8 per cent compared with 1.8 per cent) and electricity, gas, water and waste services (7.3 per cent compared with 2.0 per cent).

[10] Business expenditure on R&D includes R&D funded by industry levies.
[11] Not available for publication, but included in total

5. Key Issues

This section outlines the key issues the Commission has identified to date and information requests associated with each issue. The purpose is to generate feedback on the issues identified, to allow stakeholders to identify issues that have been overlooked and to encourage stakeholders to provide evidence relative to the issues identified.

Data is a critical issue. There are gaps and inconsistencies in several areas. R&D statistics at the state level are limited and, as a result, the Commission has made several information requests to build and enrich the evidence. The Commission will also circulate information requests to state government agencies and business to enlarge the dataset.

5.1 Defining and measuring research and development output

R&D activity can be broadly viewed as a flow where inputs (e.g. finance, people and infrastructure are transformed into outputs (e.g. journal articles, patents, etc.); subsequently leading to valuable outcomes such as new knowledge, new or improved products and new or improved processes, all of which contribute to economic growth. In addition, other channels from research include contributing to public policy making and increasing the skills and adaptability of a tertiary qualified workforce.

Attempts to measure these various consequences of R&D have relied on a range of methods including case studies, impact analysis, bibliometric analysis, surveys and economic modelling. These methods can be entirely qualitative, entirely quantitative or a combination of both.

Even the most immediate outcomes of research, such as additions to the stock of knowledge, are difficult to measure. Because of this, outputs are often used as proxies, and the choice of these proxies is often driven by data availability. In the higher education sector, the most widely used measure of R&D output is publications while in the business sector the number of patents is a common measure.

Some studies have used the amount of grant funding won, or total expenditure as a measure of output, but this may reflect data limitations as they are an input, or a method of financing inputs. For academic publications, a common quality measure is the number of citations a publication receives, although other possibilities include the reputation of the publishing journal. Table 5.1 shows the proportion of publications in the top one, five and ten per cent of citations for South Australia's main universities compared to the average for the research intensive Group of Eight universities.

Table 5.1: Number of publications in the top 1, 5 and 10 per cent of citations, all sciences, by University, 2014-17

University	Total Publications	Top 1 %		Top 5%		Top 10%	
		Publications	%	Publications	%	Publications	%
University Adelaide	5,662	86	1.5	393	6.9	751	13.3
University of South Australia	2,521	31	1.2	151	6.0	300	11.9
Flinders University	2,326	26	1.1	121	5.2	255	11.0
Group of Eight	73,189	1032	1.4	4,839	6.6	9,403	12.8

Source: CWTS Leiden Ranking 2019 [12]

[12] Centre for Science and Technology Studies, CWTS Leiden Ranking 2019, (2019), <https://www.leidenranking.com/ranking/2019/list>

There are issues with all of these measures, especially whether all new knowledge is signalled by either a publication or patent and whether publications, citations or patents are of equal value. The Commission is seeking views and evidence on the most appropriate measures of R&D output and performance throughout the inquiry.

The Commission is also interested in the productivity of resources used in R&D in South Australia. The use of the best proxies for both outputs and outcome of R&D will be important to assessing the productivity of R&D and its benefits to the SA economy.

Information request 5.1

The Commission seeks further information on:

- What are the sources of value created by R&D?
- What definitions and data could be used for measurement of inputs, outputs, productivity and impacts of R&D?
- Where and who use these measures?
- What are the limitations of these measures?
- Does the current R&D funding model allocate funding to areas which have the greatest benefits?
- How aligned are SA's research strengths with existing and future opportunities for growth in the SA economy?
- What regulatory barriers impede the translation of SA research into new products and services? How material are they compared to best practice?

5.2. Drivers of research and development output

There are many factors that are understood to drive R&D performance. They include: funding; labour force skills; the academic workforce; structure of local industry; the research infrastructure; the SA population demography; and access to data. These issues are addressed in the following sections. The Commission also seeks advice on other important drivers.

5.2.1 Funding

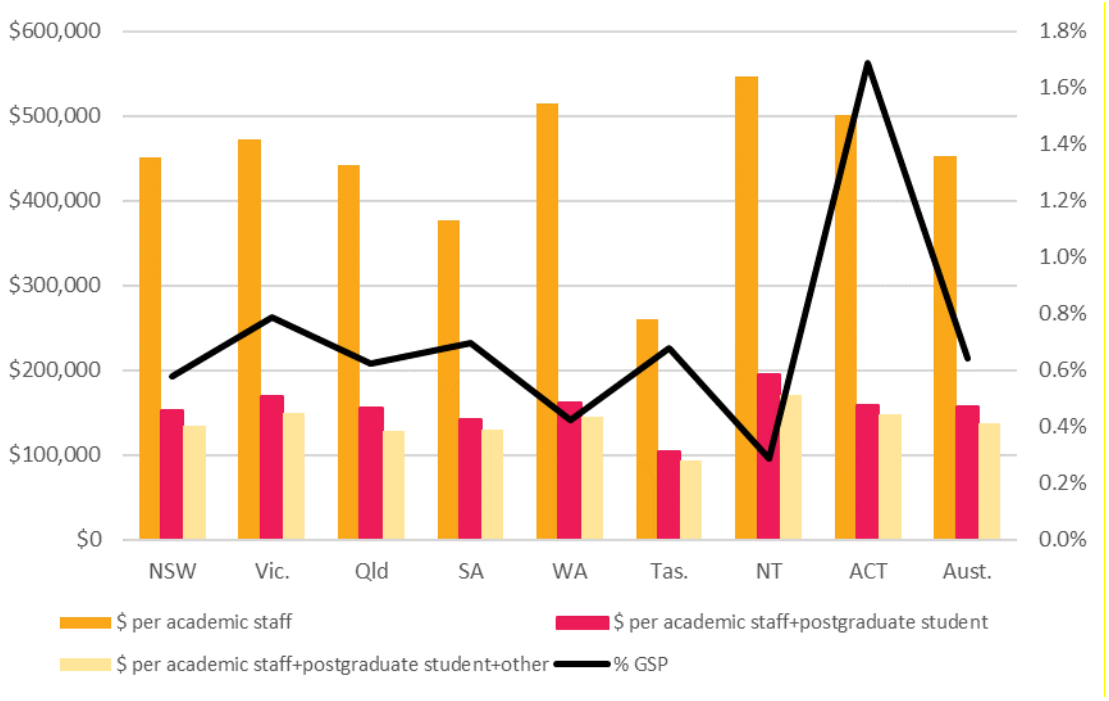
Business expenditure on R&D represents over half of all R&D expenditure in Australia. The nature of R&D means that the outcomes, costs and returns are uncertain, and it can be difficult for businesses to capture all of the benefits of R&D, which can make it difficult to access finance.[13] The presence of spillovers and the nonexcludable nature of knowledge produced by R&D can also result in businesses underinvesting in R&D from a society's perspective.

[13] Australian Government Department of Industry, Science, Energy and Resources, Research and development tax incentive, (2020), <https://www.industry.gov.au/funding-and-incentives/research-and-development-tax-incentive>

Funding also drives R&D in both the higher education and government sectors. The Commission seeks views on how funding allocations are currently made (including priorities), what improvements can be made and what role the South Australian Government might play. The Commission's interest includes: examining how successful South Australian researchers have been in applying for competitive grants; whether South Australian researchers have been sufficiently ambitious in applying for competitive grants; and whether different funding models have different implications for research output.

South Australia has the second lowest HERD expenditure per researcher in Australia[14], as shown in figure 5.1. This results from SA having a relatively high number of researchers per capita (discussed further in section 5.2.3), coupled with its share of national HERD being less than its share of national population.

Figure 5.1: Higher education expenditure on R&D per researcher (PYE) and proportion of GSP, by location, 2016



Source: ABS 8111.0, ABS 5220.0

Given the competitive nature of R&D funding, the number of researchers; the rate at which they make applications; success rates in applying for funding; and average size of grants awarded are drivers of R&D output. The ARC publishes success rates for their competitive grants programs. Table 5.2 demonstrates that South Australian universities submitted 6.4 per cent of Australia's ARC Discovery Projects applications with a success rate close to the national average. The Commission is compiling information on the other drivers of funding outcomes.

[14] Defined as either academic staff or academic staff and postgraduate students. When defined as total staff devoted to R&D, South Australia has the third lowest expenditure per research staff. The ABS measures human resources devoted to R&D in person years of effort (PYE).

Table 5.2: Success rates of ARC applications for ARC Discovery Projects, 2016-20, by state

State	Proposals submitted	Successful proposals	Success Rate (%)
Australian Capital Territory	1,104	266	24.1
New South Wales	5,394	1,067	19.8
Northern Territory	25	3	12.0
Queensland	2,523	496	19.7
South Australia	1,030	205	19.9
Tasmania	353	63	17.8
Victoria	4,351	854	19.6
Western Australia	1,276	218	17.1
Total	16,056	3,172	19.8

Source: ARC Database

As discussed in section 3.3.2, in South Australia 44.9 per cent of higher education R&D expenditure is funded from an institution's own funds. The Commission understands that a significant source of untied funding for universities is revenue from international students. The Commission will seek to further understand the drivers of expenditure on R&D from general university funds, the role of international students in this expenditure and how decisions are made about the allocation of this expenditure.

Information request 5.2

The Commission seeks further information on the following issues:

- How can South Australian businesses', universities', and research institutes' R&D funding be increased and how can this funding be better targeted?
- What role has the South Australian Government played in assisting public and private researchers to access Australian Government funding?
- What are the key factors which influence SA's total R&D funding?
- Why does such a small percentage of private non-profit expenditure on R&D occur in SA and what barriers, if any, are there to private non-profit R&D in SA?

5.2.2 Educational attainment

While South Australia faces challenges with the age profile of available labour supply, the skills within the labour force are also challenging. Typically, South Australia has lower rates of educational attainment in the labour force when compared to Australia. For bachelor degrees this is 3.8 percentage points lower, and for postgraduate degree holders it is 2.7 percentage points lower than the Australian average.

At the Certificate III and IV level, South Australia is marginally ahead of the national average. The state's industry structure clearly shapes the mix of occupations among the employed labour force; South Australia has two percentage points fewer working as professionals; with more working as labourers and as community and personal service workers.

Table 5.3: Highest level of highest educational attainment, per cent of labour force (November 2019)

Qualification Level	SA %	Aust %
Certificate III/IV	22.2	19.5
Bachelor degree	17.8	21.6
Graduate diploma / graduate certificate	3.1	3.4
Postgraduate degree	5.9	8.6

Source: ABS Cat 6291.0.55.003 Labour Force, Australia, Detailed, Quarterly

Information request 5.3

The Commission seeks information on:

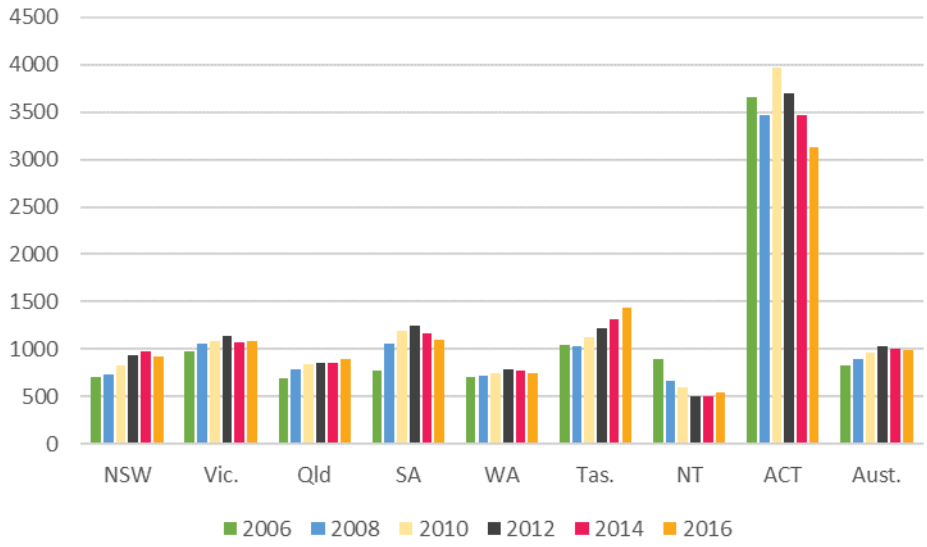
- whether the existing mix of labour force skills has a material impact on the state's ability to undertake research in the state;
- how employers might deliberately attract and retain high quality R&D talent; and
- whether the expected supply of students and graduates can support higher output in R&D.

5.2.3 Academic work force

The international flow of academic talent is an important factor in the transmission of knowledge and skills in a globalised economy and in establishing local centres of excellence. The government wants Adelaide to become a centre of future industries, including defence, space, advanced manufacturing and digital - in particular, machine learning and artificial intelligence, cyber and creative industries. The recruitment of new, world-class academic talent, and how that talent is developed, retained and rewarded is an important element in the R&D landscape for South Australia. The merits of such an approach in conjunction with developing potentially outstanding academic and research talent already in SA's research institutions, including state-funded institutions, is a matter of interest to the Commission.

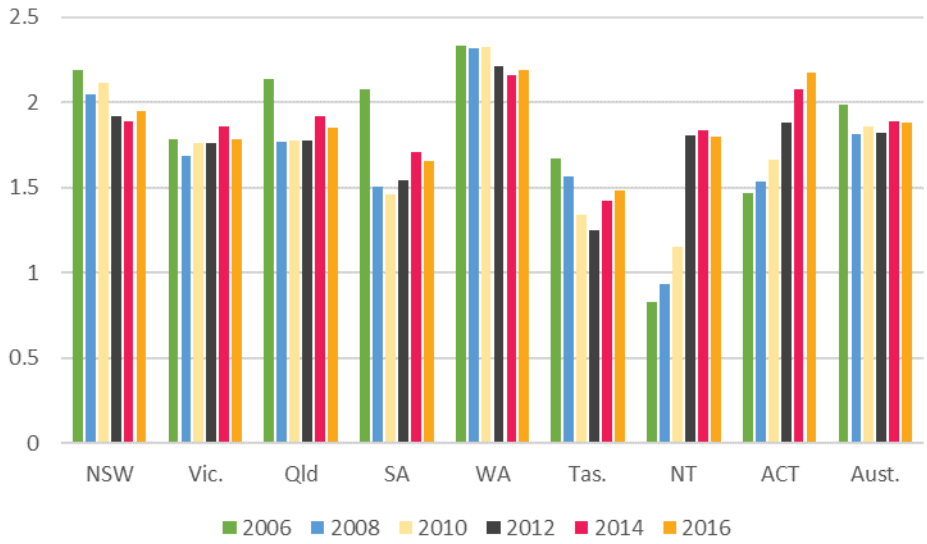
Tables 5.2 and 5.3 show the academic staff per million population and the number of PhD students per academic staff in South Australia and other states. South Australia has a relatively high number of academic staff given its overall population and number of enrolled students. It lags most other states in terms of the number of PhD students relative to academic staff.

Figure 5.2: Academic staff devoted to R&D (PYE) per 1M population, by location (number)



Source: ABS 8111.0, ABS 3101.0

Figure 5.3: PhD students per academic staff devoted to R&D (PYE), by location (number)



Source: ABS 8111.0, ABS 3101.0

Information request 5.4

The Commission seeks information on:

- How important is it to retain young researchers in SA and what incentives could be developed to do so?
- Are there any barriers to the recruitment of additional world class academic talent?
- To what extent does the existing mix of skills and fields match SA's industries?
- What are the barriers to a better match, and how can they be removed?
- Are there any barriers to the recruitment of additional world class academic talent?
- What factors are influencing the relatively low level of PhD students enrolled relative to the academic workforce?

5.2.4 Industry structure

Innovation and growth can come from all types of business working in most sectors. Some agricultural R&D is funded at an industry level, including in South Australia. That said, the state's industry composition does not appear to nurture investment in R&D. In South Australia 98 per cent of all business are small with fewer than 20 employees. Over 60 per cent of businesses do not employ any staff. In the context of this inquiry, larger businesses tend to conduct more research and development. Table 5.4 provides detail on R&D spending by industry sector and business size.

Globally, research and development is dominated by a small proportion of firms, especially multinational companies. In 2012, the top 2,000 companies accounted for around 90 per cent of the total business R&D expenditure of OECD countries plus other large economies such as Argentina, China and the Russian Federation[15].

Australia has, relative to the OECD average, a low proportion of firms which actively undertake research and development (approximately 25 per cent) with 4 industries accounting for more than 75 per cent of total expenditure. In 2015, 59 per cent of BERD in Australia was delivered in service industries. Research fields in ICT and engineering accounted for 73 per cent of BERD in Australia. This partly reflects Australia's service-oriented industry structure and the diminishing share of manufacturing in the economy (manufacturing continues to have the highest share of research and development expenditure, approximately 25 per cent of all expenditure in 2015-16)[16].

Innovation in service industries and services offered by firms resulting in innovation are key areas where improvement can offer substantial productivity gains in South Australia. Services innovation not only makes services firms internationally competitive, but also

[15] H. Dernis et al, 'World Corporate Top R&D Investors: Innovation and IP bundles' (2015), A JRC and OECD common report, Publications Office of the European Union, Luxembourg
[16] Chief Scientist of South Australia, 'The State of Science, Research and Innovation in South Australia, Internal Discussion Paper, January 2020 p6.

enables them to transmit innovative processes in other traditional industries and across the economy. Services innovations are hidden non-technological aspects of business innovation that are the source of competitiveness and productivity, and where value is created by firms.

Table 5.4: Business expenditure on R&D, by ANZIC industry subdivision, by employment size, Australia, 2017-18

Industry subdivision	0-4 persons $'000	5-19 persons $'000	20-199 persons $'000	200 or more persons $'000	Total expenditure on R&D $'000
Agriculture, forestry and fishing	29,732	34,795	161,259	87,811	313,596
Mining	128,989	179,434	168,484	572,899	1,049,805
Manufacturing	132,170	378,726	1,039,336	3,049,232	4,599,464
Electricity, gas, water and waste services	16,177	82,104	19,493	235,245	353,020
Construction	30,745	56,367	96,837	165,215	349,164
Wholesale trade	37,618	177,754	375,911	339,250	930,532
Retail trade	28,763	59,017	94,079	60,345	242,204
Accommodation and food services	1,031	5,259	12,045	19,503	37,838
Transport, postal and warehousing	2,458	13,563	31,084	73,318	120,423
Information, media and telecommunications	47,506	119,848	131,914	310,783	610,052
Financial and insurance services	24,817	116,926	288,419	2,416,829	2,846,990
Rental, hiring and real estate services	30,913	50,805	75,084	37,012	193,815
Professional, scientific and technical services	753,470	1,330,956	1,801,250	1,227,447	5,113,123
Administrative and support services	8,825	27,634	51,188	79,154	166,800
Public administration and safety	3,056	N/A[17]	13,533	N/A[4]	21,889
Education and training	8,004	N/A[4]	21,713	N/A[4]	50,604
Health care and social assistance	33,078	24,252	48,177	35,317	140,823
Arts and recreation services	5,417	7,215	46,213	63,943	122,788
Other services	26,782	46,469	61,128	40,274	174,653
Total	**1,349,551**	**2,730,556**	**4,537,145**	**8,820,333**	**17,437,585**

Source: ABS 8104.0

[17] Not available for publication, but included in total where applicable

Information request 5.5

The Commission seeks information on:

- Whether and how to encourage small and medium sized businesses to participate more in R&D.
- Whether and how to encourage interstate and international firms to invest more in SA.
- What government regulations or processes are blocking South Australian businesses from pursuing research and development opportunities?
- How can the government remove barriers for businesses to access public and private equipment and infrastructure, to enable increased research and development?
- Given that governments are key purchasers of goods and services, what reforms could be made to support business research and development growth within the SA economy?
- Are there other ways to support local businesses to invest efficiently in research and development as part of their growth strategy?
- Which industries could contribute more to rapid growth of the SA economy? Does the state have the necessary R&D base to contribute to the growth of these industries in SA?

5.2.5 Infrastructure

Research infrastructure in Australia and South Australia is owned, operated and used by a range of organisations in the higher education, government, not-for-profit and business sectors. The infrastructure is built using an array of construction models including joint ventures involving universities and public-private partnerships.

The types of infrastructure used for R&D comprise small-scale (both physical and service-based) and large-scale. Smaller infrastructure tends to be operated locally, often managed independently by an individual institution and involve smaller-scale participation by or collaboration with other organisations.

Large infrastructure investments, also known as landmark infrastructure, have national, and often global, implications that require collaboration among institutions and detailed consideration by relevant levels of government. The facilities are typically complex, serve large and diverse user communities and engage national and international collaborators in investment and in access to data and information. Larger infrastructure usually involves either the provision of pervasive infrastructure that is embedded throughout the national system or the establishment of a stand-alone research facility that will be a 'one-off'[18].

The most significant infrastructure assets in South Australia are contained within the higher education institutions and state-based operations of national research organisations funded

[18] Review of the National Innovation System (Cwth), Venturous Australia: Building Strength in Innovation, Panel Report (2008).

and operated by the Australian Government and are too numerous to mention. The South Australian Government has considerable research capability in primary industries at SARDI. Research and development providers in South Australia are discussed in more detail in section 2.2.

Information request 5.6

The Commission asks stakeholders, based on their views and experience:

- What R&D research infrastructure does the state possess? Is it nationally and/or globally competitive?
- Whether infrastructure investments in research and development infrastructure have been effective to date?
- What other roles can the state government undertake in infrastructure provision, for example coordination of joint ventures?
- What barriers exist to the efficient provision and use of R&D infrastructure in South Australia?

Science Parks and Innovation Districts

The design, establishment and operation of research and development infrastructure and the ability of this infrastructure to promote collaboration and flow of information is a critical variable in research and development outcomes. Physical proximity and closeness of technological fields and product space between researchers and business have a positive and measurable influence on research and development outcomes and hence on economic growth.[19]

Historically, research and development providers have operated using collaborative models or "clusters" for universities, research institutes, government organisations, not-for-profit groups and business based on common location in science parks and innovation districts.

The Mawson Lakes Technology Park, established in 1982, was the first example in South Australia of a suburban innovation district to promote collaboration between firms in the defence and manufacturing sectors. The cluster model has evolved in the South Australian context to science parks and precincts at Waite for agricultural science, Thebarton for the bioscience sector and Science Park at Bedford for the IT sector and health and medical cluster in North Terrace (which is covered by the health and medical research inquiry).

Key questions of these historical investments include: relative to their objectives, have they been a good use of tax payers' money; what lessons have been learned to optimise the value of future investments; and how can they contribute to lifting SA's growth and productivity?

The most recent development of this policy has been the establishment of place-based innovation districts engendering a more collaborative and complete innovation eco-system to support all aspects of developing and commercialising knowledge by connecting educators

[19] Zvi Grilliches, 'Issues in Assessing the Contribution of Research and Development to Productivity Growth' (1979) 10 (1) The Bell Journal of Economics, 92-116.

and researchers. Lot 14 and the Tonsley Innovation District have been established using this type of cluster model.

Information request 5.7

The success or otherwise of efforts to establish clusters of research and development infrastructure in common locations will be a matter that the Commission will consider. The Commission seeks feedback and advice regarding:

- whether the clusters are best practice, including in terms of location, development, operation and use of tax payer funds, and how they could be improved; and
- examples of best Australian and international practice.

5.2.6. Demography

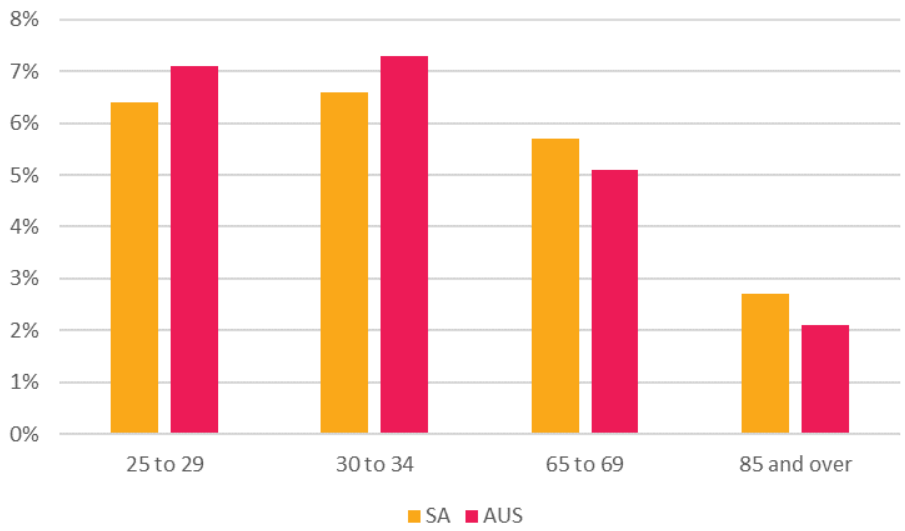
South Australia's population is older than Australia as a whole. At the 2016 Census, 18 per cent of South Australians were aged 65 years or over, compared with 15 per cent for Australia as a whole.

South Australia also has the nation's second lowest population growth. Over the last twenty years, South Australia's population grew by 15 per cent around half of the growth of the populations of Queensland, Victoria and Western Australia; and three quarters of the New South Wales growth over that period.

As a result, SA's share of the Australian population fell from almost 8 per cent to 7 per cent in that period. This decline included an outflow of people between the ages of 20 and 39 to other parts of Australia.

The major differences between the age structure of South Australia and Australia are in the over 65 cohorts; and in the 25 to 34 cohorts, as shown in Figure 5.5 below:

Figure 5.5: Percentage of population of selected age groups, South Australia and Australia, 2016



Source: Australian Bureau of Statistics; Census 2016

Information request 5.8

The Commission seeks information on the areas of opportunity that may be created by SA's age profile including examples. What R&D activity would support exploiting those opportunities?

5.2.7. Access to data

The large volume of data held by the Australian Government and its state and territory counterparts has come to be seen as an underutilised and valuable national resource.[20] The Australian Research Data Commons (ARDC) was formed in July 2018 to enable the research community's access to nationally significant data intensive infrastructure, platforms and collections of high quality data. South Australia has recently sought to enhance the way in which its public sector data is managed and used. The *Public Sector (Data Sharing) Act 2016* (SA) provides a statutory foundation for the management of the data held by public sector agencies and aims to ensure that data is used appropriately as a resource to inform policy making and service delivery.[21]

Sophisticated use of data for public policy can assist in innovating and improving the flexibility and responsiveness of public services. Similarly, there may be opportunities for commercial businesses to produce innovative services and products through the use of such information. An example is the fuel price transparency regimes in several Australian states which gather and publish fuel price information which is also published by commercial app producers.

In addition to government, businesses and universities collect large amounts of data for both R&D and other purposes.

Barriers to access of this data for R&D purposes may include privacy, integrity and cost and protecting intellectual property.

[20] See, for example, the Australian Government's Public Data Policy Statement, <https://www.pmc.gov.au/sites/default/files/publications/aust_govt_public_data_policy_statement_1.pdf>
[21] See Public Sector (Data Sharing) Act 2016, particularly s 4(a-e), <*https://www.legislation.sa.gov.au/LZ/V/A/2016/PUBLIC%20SECTOR%20(DATA%20SHARING)%20ACT%202016_61/2016.61.UN.PDF*>.

Information request 5.9

The Commission seeks further information on the following issues:

- Is the current regulatory environment at the national level conductive to data generation and sharing?
- Is the current regulatory environment at the state level, including the operation of the *Public Sector (Data Sharing) Act 2016*, conductive to data generation and sharing?
- Is there overlap between national and state legislation?
- Do privacy requirements inhibit sharing and use of data for R&D?
- What are the barriers to accessing and using public sector data for R&D in South Australia and how material are these barriers?
- How could these barriers be addressed? Are there any barriers related to sharing of data among non-government research providers created by government policy? And where is it done better?

5.3. Business investment in R&D

Research and development expenditure is the part of a business' operation that seeks to develop and apply knowledge to enhance its products, services, technologies, or processes. Along with creating new products and adding features to old ones, investing in research and development can drive product improvement or innovation of existing business processes.

As highlighted in section 5, BERD in South Australia has historically remained below and is currently below the levels of expenditure nationally. The components of this performance and underlying reasons for lagging the national average remain difficult to reconcile. Anecdotally, issues such as industry structure, few examples of head offices and lack of global integration are offered as explanations.

Important factors in facilitating research and development outcomes is the relationship between researchers, particularly higher education research, and enterprises. Access to research results and data, access to researchers and resources, such as public space and facilities, in addition to opportunities for collaboration between services providers and the research and development community are critical factors in commercial outcomes.

Adoption and diffusion of technology introduced by other businesses is currently more common in Australian businesses than both direct investment in research and development and developing new to market innovations. A low proportion of Australian firms (9.2 per cent) were engaged in new to market innovation in 2014, below both the OECD country average of 13.3 per cent and the top 5 OECD countries at 21.3 per cent[22]. Australia's participation in global value chains is also below the OECD average (as measured by the Global Value Chain Participation index). The Commission is unaware of more recent information.

[22] Chief Scientist of South Australia, 'The State of Science, Research and Innovation in South Australia, Internal Discussion Paper, January 2020 p6..

The legal protections provided by intellectual property rights such as patents, trademarks and copyright can encourage innovation by individuals and businesses. Data for patents and trademarks are considered by many policy makers to be an indication of the level of innovation in an economy. Recent statistics published by IP Australia[23] indicate that in 2018 South Australia registered 4.2 per cent of national standard patent applications and 6.0 per cent of national trademark applications. The annual number of applications filed has been decreasing in South Australia for the previous seven years.

This decline may reflect: the increasingly global nature of innovative activities; the protection of intellectual property by other means; and the smaller concentration of head offices in South Australia executing decisions on research and development and innovative projects.

Information request 5.10

The Commission seeks stakeholder views and evidence on:

- How do businesses determine the balance between adopting or innovating technology and processes as a driver of innovative products and processes?
- Are there ways that the South Australian Government can efficiently support business endeavours in R&D?

5.4. R&D collaboration

Collaboration can involve an enterprise, university or research organisation. It allows for the transfer of skills and knowledge, access to facilities and expertise and potentially new ideas that would not otherwise be realised. It also allows risk to be shared among the parties.

Collaborations can be local, national or international. Collaborations among research-based institutions commit resources and agree risk-taking among firms in an industry (or sometimes more broadly across the economy). Evidence suggests collaboration leads to a more productive outcome in research.

Research and development partnerships among researchers and enterprises recognise and value the diversity of stakeholders in the innovation process and the institutional factors governing their participation and roles. Consequently, partnerships enable the joint application of different types of knowledge, promoting not only science-based technical innovations, but also process, managerial, institutional and policy innovations.

Interactions and cooperation among stakeholders are an important feature of the research and development process and a prerequisite for research to be exploited. Lack of, or insufficient collaboration between, stakeholders often occurs due to the nature of the public research process. Policy makers globally consider this a systemic failure worthy of policy intervention and public involvement in bringing together researchers and business.

In Australia, government grant funding through the ARC provides the vehicle for business involvement in higher education driven research projects, notably ARC Centres of Excellence and the Linkage Project stream. This also occurs through projects undertaken by the CSIRO, DST and rural research corporations.

[23] IP Australia, 'Australian Intellectual Property Report 2019, Statistical Report, April 2019.

In South Australia, support for collaboration has focused on financial incentives to promote the industrial development of research through initiatives such as the new research commercialisation fund being administered by DIS.

In addition to addressing inefficiencies in research and development outcomes, policy makers have identified global trends currently shaping business research and development. Firstly, firms are doing less R&D of their own and instead seeking collaboration; and secondly business R&D crosses jurisdictional borders and is located near important markets. Major global corporations are now relocating research and development activities to fast-growing, emerging economies such as China and India to take advantage of research inputs and market size.

Information request 5.11

The Commission seeks stakeholder views and evidence on:

- best practice examples of collaboration between higher education institutions and businesses;
- the advantages and costs of collaboration among research institutions at local, national and international levels;
- examples of best practice collaborations between higher education institutions;
- incentives that encourage collaboration; and
- regulatory barriers to collaboration that the South Australian Government can address.

5.5. Possible policy instruments

The Commission's task is to provide advice and recommendations on the policy instruments that might be applied to improve research performance in South Australia. The Commission's particular focus is on the instruments that would support the productivity of resources applied to research, lead to a better allocation of resources across areas of work according to its value, assist in the translation of research outputs into various applications and ultimately to economic growth. They include:

- funding, including the size and design of programs and form of support levels;
- taxation, including the treatment of research activities and research institutions;
- regulation, including ethics, privacy, fields of technology such as GMO, intellectual property and the security of research results;
- 'buying' or providing research, including the role of state research bodies such as SARDI, and potential R&D customers such as SA Water, in relation to private firms, universities, industry bodies and joint ventures among others;
- managing the environment in which research institutions operate (e.g. mobility into and within, communications, IT capacity);
- managing the portfolio of research clusters such as Waite, Tonsley and others; and

- talent attraction, including visas and other levers.

Within the Australian context, policy settings to stimulate enterprise research and development activity at the national level concentrate on fiscal incentives for research and development and collaboration with international partners on key sectors and areas of interest (outlined in greater detail in section 3.1). These policies frame the overall architecture of state government policies and programs.

South Australia's policies and programs concentrate on financial support for industry for innovation and commercialisation of research; there is not a focus on agreements or arrangements for international collaboration that exist at the national level or in other states and territories.

Examples in other jurisdictions of research and development include:

- Queensland's Science Policy and Advance Queensland program which provide opportunities to connect industry and government on public research and provide innovation partnership grants for collaboration between researchers and business; and
- NSW Innovation Strategy, which included initiatives to foster and leverage research and development.

Information request 5.12

The Commission seeks further information on the following issues:

- What other policy instruments should the state consider?
- What are the most important policy barriers for the South Australian Government to address?
- Are there any examples of policy levers and outcomes of policy in a national or global context that could be translated to SA?

Summary of information requests

Information request 5.1

The Commission seeks further information on:

- What are the sources of value created by R&D?
- What definitions and data could be used for measurement of inputs, outputs, productivity and impacts of R&D?
- Where and who use these measures?
- What are the limitations of these measures?
- Does the current R&D funding model allocate funding to areas which have the greatest benefits?
- How aligned are SA's research strengths with existing and future opportunities for growth in the SA economy?
- What regulatory barriers impede the translation of SA research into new products and services? How material are they compared to best practice?

Information request 5.2

The Commission seeks further information on the following issues:

- How can South Australian businesses', universities', and research institutes' R&D funding be increased and how can this funding be better targeted?
- What role has the South Australian Government played in assisting public and private researchers to access Australian Government funding?
- What are the key factors which influence SA's total R&D funding?
- Why does such a small percentage of private non-profit expenditure on R&D occur in SA and what barriers, if any, are there to private non-profit R&D in SA?

Information request 5.3

The Commission seeks information on:

- whether the existing mix of labour force skills has a material impact on the state's ability to undertake research in the state;
- how employers might assertively attract and retain high quality R&D talent; and
- whether the expected supply of students and graduates can support higher output in R&D.

Information request 5.4

The Commission seeks information on:

- How important is it to retain young researchers in SA and what incentives could be developed to do so?
- Are there any barriers to the recruitment of additional world class academic talent?
- To what extent does the existing mix of skills and fields match SA's industries?
- What are the barriers to a better match, and how can they be removed?
- Are there any barriers to the recruitment of additional world class academic talent?
- What factors are influencing the relatively low level of PhD students enrolled relative to the academic workforce?

Information request 5.5

The Commission seeks information on:

- Whether and how to encourage small and medium sized businesses to participate more in R&D.
- Whether and how to encourage interstate and international firms to invest more in SA.
- What government regulations or processes are blocking South Australian businesses from pursuing research and development opportunities?
- How can the government remove barriers for businesses to access public and private equipment and infrastructure, to enable increased research and development?
- Given that governments are key purchasers of goods and services, what reforms could be made to support business research and development growth within the SA economy?
- Are there other ways to support local businesses to invest efficiently in research and development as part of their growth strategy?
- Which industries could contribute more to rapid growth of the SA economy? Does the state have the necessary R&D base to contribute to the growth of these industries in SA?

Information request 5.6

The Commission asks stakeholders, based on their views and experience:

- What R&D research infrastructure does the state possess? Is it nationally and/or globally competitive?
- Whether infrastructure investments in research and development infrastructure have been effective to date?
- What other roles can the state government undertake in infrastructure provision, for example coordination of joint ventures?

- What barriers exist to the efficient provision and use of R&D infrastructure in South Australia?

Information request 5.7

The success or otherwise of efforts to establish clusters of research and development infrastructure in common locations will be a matter that the Commission will consider. The Commission seeks feedback and advice regarding:

- whether the clusters are best practice, including in terms of location, development, operation and use of tax payer funds, and how they could be improved; and
- examples of best Australian and international practice.

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The Commission seeks information on the areas of opportunity that may be created by SA's age profile including examples. What R&D activity would support exploiting those opportunities?

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The Commission seeks further information on the following issues:

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The Commission seeks stakeholder views and evidence on:

- How do businesses determine the balance between adopting or innovating technology and processes as a driver of innovative products and processes?
- Are there ways that the South Australian Government can efficiently support business endeavours in R&D?

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- best practice examples of collaboration between higher education institutions and businesses;

- the advantages and costs of collaboration among research institutions at local, national and international levels;
- examples of best practice collaborations between higher education institutions;
- incentives that encourage collaboration; and
- regulatory barriers to collaboration that the South Australian Government can address.

Information request 5.12

The Commission seeks further information on the following issues:

- What other policy instruments should the state consider?
- What are the most important policy barriers for the South Australian Government to address?
- Are there any examples of policy levers and outcomes of policy in a national or global context that could be translated to SA?

Appendix 1

The following tables and figures provide additional detail on R&D expenditure in Australia.

Government sector

Nationally, 47 per cent of state government expenditure on R&D is solely from their own funds. The Australian Government funds 11.5 per cent of state government expenditure on R&D, while 11.9 per cent is jointly funded by business and government and 10.9 per cent is funded by other state or local governments.

Table A1: Government expenditure on R&D, by source of funds, by government level, 2016-17

Expenditure Type	Commonwealth $'000	State/territory $'000	Total $'000
Own funds	1,673,936	535,282	2,209,218
Other Commonwealth government	191,830	131,570	323,400
Other State and local government	68,622	124,505	193,127
Private non-profit organisations	8,820	96,443	105,263
Business	75,534	88,090	163,624
Joint business/government	38,823	135,271	174,094
Universities	892	8,321	9,213
Donations and bequests	8	9,453	9,461
Other Australian	280	266	546
Overseas	80,199	10,610	90,809
Total expenditure on R&D	**2,138,944**	**1,139,811**	**3,278,755**

Source: ABS 8109.0

Table A2 presents the Australian Government's expenditure on R&D by broad socio-economic objective. The Australian Government's largest investment in R&D is in universities for the general advancement of knowledge. Other significant investments include industrial production and technology (18 per cent) and health (15 per cent).

Table A2: Australian Government investment in R&D by socio-economic objective, 2018-19

Socio-economic objective	2018-19 ($M)	% of total
Exploration and exploitation of the Earth	446.57	4.6
Environment	299.61	3.1
Exploration and exploitation of space	53.49	0.6
Transport, telecommunications and other infrastructures	294.86	3.1
Energy	564.06	5.9
Industrial production and technology	1,742.14	18.1
Health	1,468.40	15.2
Agriculture	770.29	8.0
Education	41.77	0.4
Culture, recreation, religion and mass media	36.62	0.4
Political and social systems, structures and processes	595.16	6.2
General advancement of knowledge: R&D financed from General University Funds (GUF)	2,141.99	22.2
General advancement of knowledge: R&D financed from other sources than GUF	687.78	7.1
Defence	495.74	5.1
Total	**9,638.48**	**100.0**

Source: Department of Industry, Innovation and Science, 2018-19 Science, Research and Innovation Budget Tables.

The Commission notes that the South Australian government does not publish comparable information.

Higher education sector

Table A3 presents South Australia and Australia's HERD by field of research. Over one-third of South Australia's HERD is in the field of health and medical sciences, which is out of scope for this inquiry. South Australia's comparative strengths in research appear to be in information and computing sciences (12.4 per cent of national expenditure), chemical sciences (10.2 per cent of national expenditure) and agricultural and veterinary sciences (9.6 per cent of national expenditure).

Table A3: Higher education expenditure on R&D, by location, by field of research, 2016

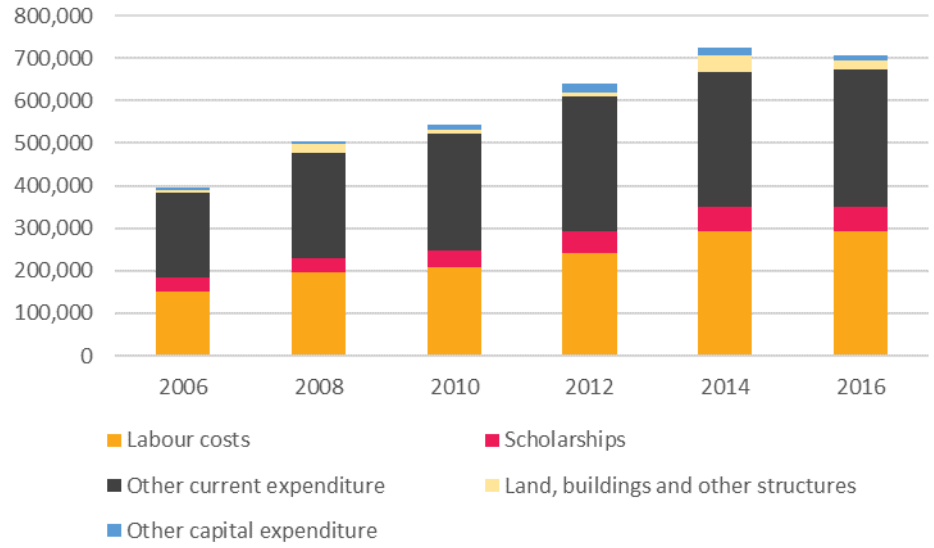
Field of Research	South Australia ($'000)	Per cent of SA total by field	Australia ($'000)	Per cent of Australian total by field	SA share of field
Mathematical sciences	7,769	1.1	205,084	1.9	3.8
Physical sciences	8,856	1.3	365,246	3.4	2.4
Chemical sciences	34,259	4.8	335,681	3.1	10.2
Earth sciences	17,690	2.5	298,041	2.7	5.9
Environmental sciences	30,920	4.4	392,718	3.6	7.9
Biological sciences	74,966	10.6	1,020,725	9.4	7.3
Agricultural and veterinary sciences	39,344	5.6	408,683	3.8	9.6
Information and computing sciences	48,849	6.9	394,399	3.6	12.4
Engineering	50,633	7.2	1,114,518	10.2	4.5
Technology	17,959	2.5	212,342	2.0	8.5
Medical and health sciences	240,324	34.0	3,086,858	28.4	7.8
Built environment and design	18,820	2.7	209,562	1.9	9.0
Education	15,718	2.2	393,726	3.6	4.0
Economics	13,986	2.0	259,966	2.4	5.4
Commerce, management, tourism and services	19,209	2.7	473,201	4.4	4.1
Studies in human society	25,735	3.6	497,470	4.6	5.2
Psychology and cognitive sciences	13,021	1.8	335,455	3.1	3.9
Law and legal studies	4,618	0.7	182,480	1.7	2.5
Studies in creative arts and writing	8,035	1.1	148,895	1.4	5.4
Language, communication and culture	9,986	1.4	280,528	2.6	3.6
History and archaeology	4,551	0.6	182,814	1.7	2.5
Philosophy and religious studies	1,923	0.3	79,128	0.7	2.4
Total	**707,171**	**100.0**	**10,877,517**	**100.0**	**6.5**

Source: ABS 8111.0

Over 95 per cent of HERD is on current expenditure, including labour costs (41.5 per cent), scholarships (8.2 per cent) and other current expenditure[24] (45.5 per cent), as shown in Figure A1. South Australia's universities have spent a lower proportion of R&D expenditure on capital over the past decade, averaging 4.9 per cent of expenditure from 2006 to 2016, compared to 8.8 per cent nationally.

[24] Other current expenditure includes the cost of non-capital purchases of materials, supplies, equipment and services to support R&D performed by the research unit.

Figure A1: Higher education expenditure on R&D in South Australia, by type of expenditure, $'000



Source: ABS 8111.0

Private sector

For Australia as a whole, more than half of BERD is attributed to businesses that employ 200 or more persons, with a further 26 per cent to businesses employing 20 to 199 persons.

Overwhelmingly, business fund their own R&D with only minor contributions from other funding sources.

Table A4: Business expenditure on R&D, by source of funds, Australia, 2017-18

Expenditure Type	Total $'000	Per cent
Own funds	16,547,715	94.9
Other business	169,096	1.0
Commonwealth government	360,752	2.1
State and local government	56,227	0.3
Other Australian	30,411	0.2
Overseas	273,384	1.6
Total expenditure on R&D	**17,437,585**	**100.0**

Source: ABS 8104.0

For more information

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