RESEARCH STRATEGIES AUSTRALIA

University Research Commercialisation – analysis of options for Australia

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Policy Drivers

The overarching policy driver needs to be clearly understood. The paper articulates it as such:

> **Australia's innovation is critically important to the long-term success of our nation, but particularly in the short to medium term COVID-19 recovery. Focusing effort on commercialisation will boost the economy and optimise community benefit from public investment in research.**

On face value there are several underlying assumptions needed to realise this policy ambition. First the economic benefits need to be realised on-shore. There are real implications for this including that the policy is most likely not about collaboration between business and universities per se, but explicitly about Australian (-based? -owned? -tax-paying?) businesses and Australian universities. It therefore appears to exclude overseas business investment into Australian research where the economic benefits are to be realised off-shore. This presumably excludes international collaborations – unless it leaves open the door to a discussion about creating value-capture mechanisms, like how international businesses benefiting from Australian university-based IP are taxed, for example. This is also important in the context of policy questions around funding university research. The crisis for the sector now is the cross-subsidy from international student revenue to sustain research expenditure. In recent years there has also been a clear direction from government to shift responsibility for funding research away from the Australian taxpayer (i.e., changes to the research block grant formulae which encouraged private investment irrespective of the geography of where value is captured).

These are very complex policy issues whose clarity will determine the appropriate mechanisms. For example, if the purpose was to continue to shift responsibility for funding research it does not matter what the source of funding is if it is not the Australian taxpayer. Or, alternatively, if it was to diversify and de-risk research funding to bolster our sovereign research capability then government must likely bear the costs, along with other sources that are under our national influence. Or, as seems to be the case, if the purpose was to drive local economic prosperity and jobs it is imperative that partners come from within Australia so that the benefits can be captured here.

If this is the agreed policy aim it is very important that any corresponding policy mechanisms must carefully cater to the local business community – you can after all only realise the benefits through the industrial sectors that we have. This has very important implications because, for example, Australia has no pharmaceutical sector to speak of (aside from pre-clinical stages we are barely involved in the drug development pathway) but does have a rich bio-tech industry. In other words, for the policy to succeed there must be a tight relationship between the incentives created and the existing private sector; and, in Australia our private sector is largely services-based (Table 1). In fact, two of three industries accounting for more than half of the net annual increase in businesses were services-based, and there were positive increases in the number of businesses across the services sector (Table 2).

Table 1 Industry shares of gross value added for selected industries, current prices[1]

Sector	2019-20 (%)
Mining	11.1
Manufacturing	6.1
Construction	7.7
Financial and Insurance Services	8.9
Professional, Scientific and Technical Services	7.6
Public Administration and Safety	5.7
Health Care and Social Assistance	7.7

Table 2 Annual percent change in businesses by industry division, 2019-20[2]

Industry	Annual percent change
Agriculture, Forestry and Fishing	-1
Mining	-0.9
Manufacturing	-0.1
Electricity, Gas, Water and Waste Services	2.5
Construction	0.6
Wholesale Trade	0.7
Retail Trade	0.8
Accommodation and Food Services	0.7
Transport, Postal and Warehousing	5.5
Information Media and Telecommunications	-0.5
Financial and Insurance Services	2.2
Rental, Hiring and Real Estate Services	1.8
Professional, Scientific and Technical Services	2.5
Administrative and Support Services	4.5
Public Administration and Safety	0.6
Education and Training	3.8
Health Care and Social Assistance	5
Arts and Recreation Services	4.4
Other Services	2.9

The Australian private sector's other defining characteristic is that it is comprised of small-to-medium enterprise, either as measured by employees (Table 3) or turnover (Table 4).

Table 3 Businesses by Main State by Industry Class by Employment Size, June 2020[3]

	Non Employing	1-19 Employees	20-199 Employees	200+ Employees	Total
Number of businesses	1,546,865	814,913	56,259	4,367	2,422,404
% of businesses	64%	34%	2%	0%	100%

Table 4 Businesses by Main State by Industry Class by Turnover Size Ranges, June 2020[4]

	Zero to less than $50k	$50k to less than $200k	$200k to less than $2m	$2m to less than $5m	$5m to less than $10m	$10m or more	Total
Number of businesses	687,493	778,114	787,604	96,436	34,548	38,209	2,422,404
% of businesses	28%	32%	33%	4%	1%	2%	100%

This observation is especially important if the policy ambitions are, as outlined, to be realised in the short-to-medium term as part of the COVID-19 recovery. In that time horizon we must 'work with what we've got' rather than await large structural transformations to our industrial base or workforce.

To be blunt, to capture the most economic benefits in the short-to-medium term any mechanisms would need to have a strong focus on opportunities in services sector and be readily accessible to SMEs.

It is also important to understand the underlying logic of the proposed policy. There are two separate (possibly connected) aspects within the consultation paper. First "a model for university research commercialisation (URC)"; second, "mechanisms to incentivise and increase partnerships between businesses and universities".

These are not mutually dependent – commercialisation of university research can occur without partnerships between business and universities e.g., spin-outs whose equity is held by universities; partnerships between business and universities can also exist that are not focused on the commercialisation of university research e.g., that are focused on solving short term business problems, providing training etc.

This is simply to say that any proposed relationship between these two issues needs to be well understood as this will determine the design of the subsequent policy mechanisms. That said, the paper implies that commercialisation is an outcome of university-industry collaboration:

> **Industry-university collaboration is a key mechanism for the translation and commercialisation of research, as knowledge is transferred between sectors resulting in innovation**

In other words, research is performed in one sector (universities) and commercialised in another sector (business).

International comparisons

If the policy is fundamentally about translating/transferring knowledge produced in universities into the private sector where it can be commercialised, a consideration is the ability of industry to understand and apply this knowledge – so-called absorptive capacity.[5] A quick indicator of the relative absorptive capacity of different industries is their current expenditure on R&D. Services sectors fill out the first, third and seventh place in the top 10 industries on such a list (Table 5). This analysis also shows the large concentration of R&D within a small number of industries - Professional, scientific and technical services ($5,113 million or 29%), Manufacturing ($4,599 million or 26%), Financial and insurance services ($2,847 million or 16%) and Mining ($1,050 million or 6%). account for more than three quarters (78%) of total business expenditure on R&D (BERD).[6]

As far as absorptive capacity, then, these four industries should naturally have the most. In the terms of short-to medium-term benefits from greater collaboration and resulting commercialisation, then, these industries should be the natural focus.[7]

In terms of comparator countries, absorptive capacity is also an important contextualising factor. It makes little sense to replicate schemes here that are designed for economies and workforces that are very different from here. Looking at the proportion of researchers that are employed in the business enterprise sector as a percentage of total researchers is a quick measure of national absorptive capacity -the more researchers there are in business the greater the ability to understand and apply knowledge. In this respect it is evident that Japan and the US – where over 70 per cent of researchers are in business enterprise – are very different from the UK and New Zealand in particular where this is less than 40 per cent (Table 6).[8]

Table 5 BERD, by top ten industries

Industry	2017-18 ($m)
Professional, scientific and technical services	5,113
Manufacturing	4,599
Financial and insurance services	2,847
Mining	1,050
Wholesale trade	931
Information media and telecommunications	610
Electricity, gas, water and waste services	353
Construction	349
Agriculture, forestry and fishing	314
Retail trade	242

Unfortunately, Australia does not currently collect and report these data – the last available data for Australia are from 2008 when only 29.9 per cent of researchers were employed in business enterprise.[9] For the sake of comparison, time Japan recorded 74.8 per cent, Canada 59.9 per cent, the UK 32.8 [per cat the same ent and New Zealand 32.8 per cent. Based on this it is safe to assume that Australia has absorptive capacity like the UK and New Zealand, not Japan or the US.

Table 6 Business Enterprise researchers as a per centage of total researchers

Comparator country	Business enterprise researcher %	Government, higher education, and private non-profits researcher %
Japan	73.4	26.6
United States	71.1	28.9
Canada	56.0	44.0
United Kingdom	38.2	61.8
New Zealand	36.9	63.1

Another quick measure is to understand the relative share of R&D expenditure that different sectors shoulder. So, for example, in Japan over 79 per cent of gross expenditure on R&D is from the business enterprise sector, and in the US almost two thirds (Table 7).[10]

Table 7 Percentage of GERD financed by the business enterprise sector

Comparator country	% of GERD financed by business enterprise
Australia	52.7[11]
Canada	41.1
NZ	46.4
Japan	79.1
UK	54.8
US	62.4

The point is not to say that one system is better or worse than another – there is clearly no one universal model. And this is the point – the idea that one country can simply borrow programs and policies from another country is a fundamentally flawed premise.

Any policy – especially one that has ambitions to deliver short-to-medium-term benefits – needs to be built with a deep appreciation of the existing system of innovation and research and where economic value is created. There must also be fundamental consideration to the question of 'value capture' mechanisms – there is no community benefit from public investment in research if all the value is privately accumulated.

Existing Mechanisms

The different models that are provided are strikingly similar to existing programs:

- **Stage-gated scheme = Accelerating Commercialisation; various programs under the MRFF incl. Frontiers in Health and Medical Research**
- **Incentives for participation = CRC especially CRCP; ARC Linkage; various NHMRC rounds; voucher programs at various state levels**
- **Industry-university collaboration = see above; also infrastructure funded out of NCRIS; ARC ITRP.**

This also has to be understood in the context of the current research block grants (half of the support from government for university research) which already has the revenue universities derive from industry as the single largest input into its allocation.

There are also a raft of funding mechanisms and policies that were scrapped by the current government that were directed at many of the outcomes described in the paper e.g., JRE program from the research block grants and mission-based compacts.

Comparator Programs

UK Grand Challenges

The UK Grand Challenges aims to put the UK at the forefront of the industries of the future, ensuring that the UK takes advantages of major global changes, improving people's lives and the country's productivity. It was first described in the UK's Government Industrial Strategy- Building a Britain fit for the future published in November 2017 which set out a plan to improve productivity and shape the economy after exiting the EU. The first wave of challenges launched in 2017 with a second wave launched in 2018 and a third wave launched in 2019. Twenty-one challenges are organised into four "Grand Challenges" and are focused on the global trends which will transform UK's future[12]:

- Artificial Intelligence and data (put the UK at the forefront of the AI and data revolution) - Use data, Artificial Intelligence and innovation to transform the prevention, early diagnosis and treatment of chronic diseases by 2030
- Ageing society (harness the power of innovation to help meet the needs of an ageing society) - Ensure that people can enjoy at least 5 extra healthy, independent years of life by 2035, while narrowing the gap between the experience of the richest and poorest
- Clean growth (maximise the advantages for UK industry from the global shift to clean growth) - At least halve the energy use of new buildings by 2030 and establish the world's first net-zero carbon industrial cluster by 2040 and 4 low-carbon clusters by 2030
- Future of mobility (world leader in the way people, goods and services move) - Put the UK at the forefront of the design and manufacturing of zero emission vehicles, with all new cars and vans effectively zero emission by 2040

Funding

By January 2021, the Industrial Strategy Challenge Fund (the Fund) was supporting 1,613 projects contributing to one of the 24 approved challenges each linked to one of the four grand challenges. UK Research and Innovation (UKRI) has so far spent around £1.2 billion of the eight-year budget of £3.0 billion funding projects. To date, industry has contributed £567 million against the Fund's co-investment target of £2.8 billion. UKRI currently forecasts it will meet this target over the life of the current challenges.

Progress

Artificial intelligence and data

- established a new joint unit, NHSX bringing together world-leading tech, digital, cyber and data experts to transform the NHS and care sector into the world's most advanced health and care system
- published the Code of conduct for data-driven health and care technology with input from NHS, academic and industry partners
- produced the AI State of the Nation survey, showing how AI is already benefitting the health and care sector, and identifying some of the barriers to wider deployment
- published the results of the follow-up survey in our report, Artificial Intelligence: How to Get it Right
- supported innovative technologies with around £100 million of government funding, including:
    - launching the Digital Health Technology Catalyst, a £35 million fund provided by government over 4 years to support the development of a range of exciting digital interventions from across the UK
- announced improvements to the Accelerated Access Collaborative (AAC) to become the new umbrella organisation for UK health innovation, acting as the 'front door' for innovators looking to get their products funded
- launched 5 centres of excellence in digital pathology and radiology, which will put the UK at the forefront of the application of AI and machine learning to improve diagnosis and deliver precision treatments
- launched a competition for new Digital Innovation Hubs with an investment of £37.5 million from the Industrial Strategy Challenge Fund

Ageing society

- announced £98 million investment through the Healthy Ageing Industrial Strategy Challenge Fund to stimulate well-designed innovations that support people to enjoy active and independent lives for longer.
- announced Andy Briggs as the Business Champion and plans to establish a UK Longevity Council to help the UK seize the economic opportunities of ageing societies
- launched a joint UK–Japan competition to support British and Japanese businesses to harness AI and robotics to develop and showcase a new generation of assisted living products
- announced plans to launch a 'Home of 2030' design and innovation competition later this year – with the Clean Growth Grand Challenge - which will seek to prototype the homes of the future, that are built to a standard suitable for the changing needs across a lifetime, whilst also being environmentally sustainable
- published Greater Manchester's Local Industrial Strategy with a focus on seizing the opportunities of an ageing population building on its status as the UK's first World Health Organisation Age Friendly city-region
- part-funded the new National Innovation Centre for Ageing in Newcastle, which is due to open later this year
- announced over £130 million investment to support healthcare innovation, including £69.5 million through UKRI's Strategic Priorities Fund to unlock new treatments that allow people to lead healthier and longer lives

Clean growth

- published the Construction Sector Deal
- established the Active Buildings Centre with £36 million investment from government and industry to develop new building materials which generate electricity from light and heat
- invested £72 million to establish a Construction Innovation Hub, a partnership between the Manufacturing Technology Centre, Building Research Establishment and the Centre for Digital Built Britain, to support research into developing and commercialising digital design and offsite manufacturing technologies
- committed to adopt the new Future Homes Standard by 2025 to ensure all new homes are future-proofed with low-carbon heating and world-leading levels of energy efficiency

- launched supply chain pilots worth up to £3 million to test different approaches to increase the rate of energy efficiency improvement by supporting local supply chain integration and project coordination

Future of mobility

- published the Road to Zero strategy setting out our comprehensive plans to support the transition to zero emission vehicles, including:
    - ambition for at least 50% — and as many as 70% — of new cars sold to be ultra-low emission by 2030
    - a commitment to massively expand electric and low emission vehicle infrastructure across the country
- hosted the world's first Zero Emission Vehicle Summit in Birmingham, where:
    - announced a £100 million boost for R&D in zero emission vehicle technology
    - industry announced £500 million investment creating over 1,000 jobs across the UK, including £200 million for EV Network, a UK-based charging station development company, and £50 million for a new Aston Martin facility in St Athan Wales
- launched the Poland-UK e-mobility declaration, at the UN climate COP24 negotiations, signed by nearly 50 governments
- passed the Automated and Electric Vehicles Act, giving the government new powers to improve the customer charging experience, require chargepoints to be smart and increase chargepoints at key locations
- invested £246 million in the Faraday battery challenge to drive innovation and scale-up facilities for batteries for electric vehicles, including a UK Battery Industrialisation Centre in Coventry
- announced £78 million from the Industrial Strategy Challenge Fund (Stephenson Challenge) to drive the electric revolution

Short summary of performance

Across the Challenges there is little by way of outcomes let alone impacts from the program – most of the work has been planning and spending. The key indicator is the leveraged industry funding which, while projected to meet its goal by, has at the half-way point spent 40 percent of its funding but leveraged 20 per cent of its target.

It is important to note a) how targeted the Challenges are e.g. AI in health care, and b) how integrated the government, private and research sectors are e.g. Automated and Electric Vehicles Act is pr-competitive work needed to seed the industry. This is not a market-driven this is government intervention to create new industries.

UK Catapult Network

Catapults are independent not-for-profit private organisations transforming the UK's capability for innovation in sectors of strength. They connect businesses with the UK's research and academic communities. The Catapult Network brings together nine leading technology and innovation centres spanning over 40 locations across the UK.

The Catapult Network supports businesses in transforming ideas into products and services through a network of technology and innovation centres established by Innovate UK (IUK) aimed to deliver impact across the UK economy, enabling businesses to thrive in global export markets. Each Catapult centre specialises in a different area of technology, but all offer a space with the facilities and expertise to enable businesses and researchers to collaboratively solve problems and develop new products and services on a commercial scale. In late 2010 the UK Government provided over £200 million of additional funding to IUK to establish The Catapult Network.

The nine Catapult centres are:

- High Value Manufacturing (Leading UK's green manufacturing revolution)
- Offshore Renewable Energy
- Cell and Gene Therapy
- Connected Places
- Satellite Applications
- Digital
- Energy Systems
- Medicines Discovery
- Compound Semiconductor Applications

According to the 2021 summary report 'Catapults: bridging the gap between research and industry' [13] Catapults face several barriers to achieving their objectives, which limit their potential contribution to delivering the ambitious R&D Roadmap. The UK's research and innovation system has the necessary components to be successful, but it lacks the scale to deliver a large increase in commercial

exploitation. It recommends the Government and Innovate UK need to consider how public sector resources and private investment can be made to match the ambitions of the R&D Roadmap by considering strategic decisions to help the different parts of the innovation system. This includes:'

- strengthening links between universities and industry;
- ensuring key performance indicators more effectively incentivise Catapults and relevant academic disciplines; and
- providing long-term certainty for the Catapults.

In assessing the economic impact of the Catapults, it was noted that while it was hard to quantify the economic impact robustly with the data available, there is some evidence that Catapults have generated additional economic impact. The view is that given the lack of a clearly articulated set of objectives and a framework for measuring impact, together with the performance of the Catapult Network since inception, it is more likely than not that, to 2017, this additional economic impact has not been significant.[14] An evaluation framework has since been established to assist with future reporting.

Funding

The Catapults have been traditionally funded with £50 million per new Catapult across five years, with a 'flat' funding profile of £10 million per annum. After five years, the Catapult must apply for its grant to be renewed subject to approval of a business plan for the subsequent five years.

Overall Research and Development (R&D) Investment in the Catapult Network for the 2019-2020 time period amounted to a total £744 million of which:

- £236 million core grant investment in capability
- £154 million commercial investment in projects
- £130 million collaborative R&D wins
- £224 million CR&D leveraged

Progress

Since 2013, Catapults have collectively played a lead role in delivering major R&D programmes involving over 14,000 collaborations with industry, 5,000 partnerships

with academia, and supported more than 8,000 SMEs, leading to the creation of jobs, supply chain and sector development, new sources of revenue and investment. Below is a quick overview of the achievements and impact of the UK Catapult Network between 2013-2020:

- 14,750 industry collaborations;
- 8,332 SMES supported;
- 5,108 academic collaborations;
- 4,712 employees in 2019;
- over £1.3 billion of research and demonstration facilities under management;
- 1,218 international projects.

Short summary of performance

The recent report from the House of Lords (February, 2021) identifies that the Catapult program is not delivering on its promise and still faces the same issues that it was designed to address: namely scale and translation of research into commercial outcomes. Earlier work by EY (2017) similarly identified that there was a lack of demonstrable impacts stemming from the early days of the program. While there is a seeming high level of activity there is a distinct lack of benefits to point to, let alone evidence including a counterfactual to demonstrate the impact of the Program.

Japan Moonshot Research and Development Programme Missions

In 2019, Japan launched the Moonshot Research & Development Program, a 100-billion-yen ($963 USD million) initiative to address major social problems including aging populations, which is especially pressing in Japan.[15]

The program was launched by the Science, Technology and Innovation Cabinet Office, Government of Japan. It promotes high-risk, high-impact R&D aimed to achieve ambitious Moonshot Goals and solve issues facing future society such as super-aging populations and global warming, by 2050.
Seven Moonshot goals were decided in the area of society, environment, and economics, goals 1 to 6 are run by the Council for Science, Technology and Innovation and were decided in January 2020 and goal 7 is run by the Headquarters for Healthcare Policy and was decided in July 2020:

- Moonshot Goal 1 – Realization of a society in which human beings can be free from limitations of body, brain, space, and time by 2050.
- Moonshot Goal 2 – Realization of ultra-early disease prediction and intervention by 2050.
- Moonshot Goal 3 – Realization of AI robots that autonomously learn, adapt to their environment, evolve in intelligence and act alongside human beings, by 2050.
- Moonshot Goal 4 – Realization of sustainable resource circulation to recover the global environment by 2050.
- Moonshot Goal 5 – Creation of the industry that enables sustainable global food supply by exploiting unused biological resources by 2050.
- Moonshot Goal 6 – Realization of a fault-tolerant universal quantum computer that will revolutionize economy, industry, and security by 2050.
- Moonshot Goal 7 – Realization of sustainable care systems to overcome major diseases by 2040, for enjoying one’s life with relief and release from health concerns until 100 years old

Funding

According to the program outline in the Moonshot Goals for the Moonshot Research and Development Program, a fund for the program was created in late 2018 which included[17]:

- 100 billion yen ~ USD $963 million was appropriated in the supplementary budget for FY2018;
- 15 billion yen ~USD $145 million was appropriated in the supplementary budget for FY2019;
- Government support of the program up to 10 years.

Progress

As the program has recently begun, below are the proposed targets of the Moonshot Goals:

Target of Moonshot Goal 1:

- Cybernetic avatar infrastructure for diversity and inclusion
    - Development of technologies and infrastructure to carry out large-scale complex tasks combining large numbers of robots and avatars teleoperated by multiple persons by 2050.
    - Development of technologies and infrastructure that allow one person to operate more than 10 avatars for one task at the same speed and accuracy as one avatar by 2030.
- Cybernetic avatar life
    - Development of technologies that will allow anyone willing to augment their physical, cognitive, and perceptional capabilities to the top level, and spread of a new lifestyle that will be welcomed by society, by 2050.
    - Development of technologies that will allow anyone willing to augment their physical, cognitive, and perceptional capabilities for specific tasks, and proposal of a new lifestyle that will be welcomed by society, by 2030.

Target of Moonshot Goal 2:

- Establishment of a system for disease prediction and evaluation of pre-symptomatic states in order to suppress and prevent disease onset, through integrated analysis of the entire functional network between human organs, by 2050.
- Establishment of a strategy that enables the conversion of a pre-symptomatic state to a healthy state, by clarification of functional changes in human physiology along life course considering the comprehensive network between organs, by 2050.

- Identification of disease-related network structures and establishment of innovative prediction and intervention methods by 2050.
- Understanding of the comprehensive network between human organs by 2030.

Target of Moonshot Goal 3:

- Development of AI robots that humans feel comfortable with, have physical abilities equivalent to or greater than humans, and grow in harmony with human life, by 2050.
- Development of AI robots that behave well with humans under certain conditions and allow over 90% of people to feel comfortable with them, by 2030.
- Development of an automated AI robot system that aims to discover impactful scientific principles and solutions, by thinking and acting in the field of natural science, by 2050.
- Development of an automated AI robot system that aims to support the process of discovery for scientific principles and solutions to specific problems by 2030.
- Development of AI robots that autonomously make judgements and act in environments where it is difficult for humans to act by 2050.
- Development of AI robots that operate unattended under human supervision in specific circumstances by 2030.

Target of Moonshot Goal 4:

Solutions to the global warming problem (the Cool Earth) and environmental pollution problem (the Clean Earth) through realization of sustainable resource circulation for the global environment.

- Cool Earth and Clean Earth
    - Global deployment of commercial plants or products utilizing circulation technology by 2050.
- Cool Earth
    - Development of circulation technology on a pilot scale for reducing greenhouse gases that is also effective in terms of life cycle assessment (LCA) by 2030.
    - Clean Earth
    - Development of technology on a pilot scale or in a form of prototype that converts environmentally harmful substances into valuable or harmless materials by 2030.

Target of Moonshot Goal 5:

- Technical development of the circular food production systems by biological measures, e.g. utilizing microbes and insects, by 2050.
- Development of the technical solutions for eliminating food loss and waste and for achieving both healthy life and sustainable food consumption by 2050.
- Evaluation of the technical achievements and discussion on the ethical, legal and social implications (ELSI) matters will be done by 2030, for global spread of the technology by 2050.

Target of Moonshot Goal 6:

- Achievement of the large-scale integration required for fault-tolerant universal quantum computers by around 2050.
- Development of a certain scale of NISQ computer and demonstration of the effectiveness of quantum error correction by 2030.

Target of Moonshot Goal 7:

- Establish infrastructure to maintain good mental and physical health by developing technologies, in order to stay healthy and prevent the onset and aggravation of diseases by regulation of immune systems or sleep, etc., and to visualize individual physical and mental state in daily life and urge people to voluntarily take healthy maintenance actions most suitable for them by 2040.
- Develop technologies to monitor all living body trends with lower physical and mental load by 2030.

Short summary of performance

The most striking aspect of this program is how non-commercial the intended impacts are. This makes sense as the program is about directing the private sector towards common-good aims and public benefit and away from commercial motivations.

Australia's Low Emission Technology Statement

Australia's Technology Investment Roadmap is a research and development strategy to accelerate development and commercialisation of low emissions technologies. The Low Emissions Technology Statement (the Statement) is the first major milestone in the Roadmap. The Minister for the Department of Industry, Science, Energy and Resources announced the first Statement on 22 September 2020[16].

The Government's efforts will focus on new and emerging technologies with the potential for transformational economic and emissions outcomes, in Australia and globally. It will enact change by:

1. Accelerating technology development through an investment and incentives framework that spans from research and development to pre-commercial deployment;
2. Enabling Government agencies to invest in the next generation of technologies through a legislative and regulatory reform package; and
3. Working together with trading partners, because delivering global outcomes requires international collaboration.

Five priorities for this first Statement were selected, with priorities anticipated to be updated each year:

- clean hydrogen under $2 per kilogram;
- energy storage electricity from storage for firming under $100 per MWh;
- low carbon materials low emissions steel production under $900 per tonne and low emissions aluminium under $2,700 per tonne;
- CCS – CO_2 compression, hub transport and storage under $20 per tonne of CO_2;
- soil carbon measurement under $3 per hectare per year.

Funding

The Australian Government has been a significant investor in a wide range of low emissions technologies, having invested over $10 billion on research, development, demonstration and commercialisation since 2014-15 . The biggest investments

have been in solar (over $3 billion), energy efficiency (almost $3 billion) and wind (over $1 billion). The bulk of this investment (more than 85%) has been aimed at commercialisation, mostly through finance from the Clean Energy Finance Corporation (CEFC). Around 5% has been invested in demonstration projects and around 9% has been invested in public research and development.

Through a public-private funding partnership the Government:

- Aim to catalyse $3–$5 of new investment for each dollar of commonwealth funding to achieve $50 to $100 billion in new investment domestically over the decade to 2030;
- A technology investment framework to improve coordination of delivery agencies – The Australian Renewable Energy Agency (ARENA), the Clean Energy Finance Corporation (CEFC) and Clean Energy Regulator (CER) – towards national technology priorities and expected Government investment of $18 billion in low emissions technologies over the decade to 2030;
- Retain ARENA on the frontline of direct government investment in low emissions technologies, playing a central role in delivering Roadmap priorities. New funding for the CEFC to support grid reliability;
- ARENA working with the CEFC and other agencies to develop a goal-oriented program for priority low emissions technologies like low emissions steel, low emissions aluminium, and energy storage;
- Establish Australia’s first regional hydrogen hub co-locating domestic hydrogen users with an export focus to create global hydrogen supply chain linkages; and
- Scale CCS to support emissions reduction from power generation, oil and gas extraction, natural gas processing, industry or hydrogen production.

Progress

Anticipated impact of the selected priorities from the Statement:

- overachieve on Paris Agreement commitments, with a pathway to deeper emissions reductions beyond 2030;
- support over 130,000 jobs by 2030 with more than half in regional communities;
- preserve and expand employment in energy-intensive manufacturing sectors;
- avoid around 250 million tonnes of emission per year by 2040 through deployment of priority technologies at home and Australia's low emissions

- exports; and
- significantly reduce global emissions from energy, transport, industry and agriculture if priority technologies achieve widespread deployment.

Short summary of performance

It is too early to say what the impacts are. It is difficult to see equivalent priorities as set out in the first Statement being developed for other areas.

Canada's Industrial Research Assistance Program

Canada's Industrial Research Assistance Program (IRAP) is a longstanding program initiated in 1962 under the National Research Council. The National Research Council of Canada Industrial Research Assistance Program (NRC IRAP) provides advice, connections, and funding to help Canadian small and medium-sized businesses increase their innovation capacity and take ideas to market. The program's mission is to accelerate the growth of small and medium-sized businesses by providing them with a comprehensive suite of innovation services and funding.[17] More than 250 Industrial Technology Advisors (ITAs) and 130 offices across Canada give access to the NRC IRAP. The role of the ITAs is to:

- Identify SMEs that have the potential to benefit from IRAP's assistance
- Establish relationships with these SMEs, which begins by working with them to identify their needs and explore opportunities to grow and successfully develop and commercialize new products and services
- Work with these companies to provide advisory assistance and funding contributions that are best suited to support their growth and profitability

IRAP proposes to accomplish its mission through two strategic objectives, which are to:

1. provide support to SMEs in Canada in the development and commercialization of technologies; and
2. collaborate in initiatives within regional and national organizations that support the development and commercialization of technologies by SMEs.

NRC IRAP at a glance for the 2017-2018 time period[21];

- Serving 8,000 + clients (2017-18)
- Clients across all industry sectors
- Funding 3,000 + clients (2017-18)
- Field staff: 255 ITAs
- Partner Organizations: 200 +

An evaluation of IRAP was undertaken in 2016-17. It was conducted based on the five-year evaluation cycle mandated by the Financial Administration Act and in accordance with NRC's Evaluation Plan. It examined the relevance and

performance of IRAP between fiscal years 2012-13 and 2016-17.[18] Overall, the findings of the evaluation confirm that IRAP addressed the needs of Canadian SMEs for support to be innovative and that it played an important role in strengthening the innovation capacity and accelerated growth of its clients. While there are areas for improvement, IRAP worked to deliver the program efficiently and effectively. Implementation of recommendations will facilitate improvements to its efficiency and effectiveness, such as:

- IRAP depended heavily on its existing network of clients and has an opportunity to develop a targeted strategy to reach new clients as well as to better understand its reach
- Resource constraints continued to pose barriers to efficient and effective delivery

Funding

NRC IRAP provides funding to support research and development projects at various stages of the innovation cycle. IRAP offers non-repayable financial assistance covering 80% of salaries and 50% of contractor costs under the following subprograms:

1. Small Technology Innovation Projects, or the Accelerated Review Process (ARP);
2. Mid-sized Technology Innovation Projects
3. Youth Employment Strategy Programs

The total project costs and allocated funding are determined by working with an NRC IRAP ITAs.

In 2018 2019, NRC IRAP was mandated to expand its support to include an increased funding threshold for business research and development for projects up to a new threshold of $10 million, up from $1 million previously.
The NRC IRAP received the following funding for 2021-22:

- $405.2 million for NRC IRAP’s Innovation Assistance Program to help high-potential firms, support jobs and keep valuable intellectual property in Canada;

- $15 million for the launch of an NRC IRAP – Innovative Solutions Canada COVID initiative;
- $11 million NRC IRAP – Innovative Solutions Canada – Medical Countermeasures III
- $10 million to NRC IRAP – Vaccines and Therapeutics

Progress

In 2021–22, NRC IRAP will continue to make its specialized services, advice and funding more accessible to accelerate the growth of small and medium-sized enterprises (SMEs), helping them build innovative capabilities and bring ideas to market.

Creating Canadian wealth through innovation

The NRC has established itself as a partner for Canadian SMEs and a driver of economic growth, jobs, and opportunities in Canada. In 2021–22, NRC IRAP will help SMEs reach their potential and grow to scale through continued advisory and financial support to the following strategies and initiatives:

- The NRC will continue to support Employment and Social Development Canada's Youth Employment and Skills Strategy, through the placement of graduates within SMEs. NRC IRAP will seek to ensure that young professionals face fewer barriers in joining the workforce and that recent Science, Technology, Engineering and Mathematics (STEM) graduates have access to quality employment in their field of study.
- NRC IRAP will focus on the growth of high potential, high growth Canadian SMEs by providing specialized advisory services to new and existing clients and facilitating increased collaboration with other government departments (OGDs) by referring these SMEs to government programs and supporting assessments for OGD partners. NRC IRAP will continue to leverage the $150M in additional, ongoing funding and continue to improve the pilot framework for the delivery of Large Value Contributions.

To support high potential, innovative Canadian firms in recovering from the COVID-19 pandemic, the NRC will focus on targeted strategic account management, enhanced efforts to increase awareness of NRC intellectual property (IP) assets,

and licensing of NRC IP to high potential, innovative firms for commercialization. Dedicated business development staff and tools will help facilitate access to NRC services and assets, thus improving responsiveness to innovative partners.

Supporting SME emergence into domestic and global markets

By collaborating with OGDs and industry, the NRC helps SMEs to build innovative capabilities, scale up, and take their ideas to market. In 2021–22, the NRC will leverage its specialized advice, services and infrastructure to support the growth of high-potential Canadian businesses.

- The NRC will continue to work with Innovative Solutions Canada (ISC) and partner organizations to sponsor and fund Canadian SMEs solving COVID-19-related challenges. NRC IRAP received $17M in 2020–21 and another $13M in incremental federal funding for 2021–22 to support Canadian SMEs with pre-commercial R&D to address COVID-19-related needs. Plans for the ISC Testing Stream include two to three calls for proposals, with 2,500-3,000 OGD assessments estimated for completion in 2021–22.
- The NRC will continue co-delivery of the CanExport Program with Global Affairs Canada (GAC) and offer a streamlined, end-to-end funding application process to SMEs, with referrals by Industrial Technology Advisors (ITAs). CanExport expects an increase in funding applications and aims to support an estimated 1,200 SMEs in accessing international markets.
- Building on world-competitive strengths in academic research and prototyping at the NRC, and systems integration through other players of the Canadian photonics ecosystem, the NRC will lead a Photonics Ecosystem Initiative aimed at expanding services to allow the Canadian photonics industry to develop full solutions and take their innovations from concept to market.

Fostering international co-innovation opportunities

Leveraging NRC IRAP's internationally recognized model of combining advisory services and financial assistance to Canadian firms, the NRC will support Canadian SME expansion in global markets through a number of international initiatives in 2021–22.

- The NRC's established on-the-ground presence in Germany and Japan will be leveraged to further build international relations and establish innovation

ecosystem linkages for collaboration with global leaders in science, technology and innovation. This presence will help advance NRC R&D initiatives and Challenge Programs that tackle prevalent issues in Canada and around the world.

- The NRC will continue to deliver the Canadian International Innovation Program in partnership with GAC and the Trade Commissioner Service to support SME expansion into global markets including India, Brazil and South Korea.
- Through EUREKA, NRC IRAP will support international co-innovation opportunities for Canadian SMEs using advisory and funding support to engage with the best partners. The Global Value Chain pilot program will continue to enable SME partnerships with large multinationals and facilitate global market access.
- Focusing on the development of support tools and resources for research centres to increase efficiency and effectiveness of international collaboration, the NRC will test new collaboration models to bring together partners from academia, industry and government, and seek to incorporate EDI best practices.
- NRC IRAP recognizes that greater diversity in international co-innovation collaborations will lead to improved global competitiveness for all partners, and it will work with international partners to benchmark innovation programming, share information and learn from best practices in implementing diversity and inclusion policies.

Short summary of performance

This program is entirely designed to promote innovation amongst SMEs and has no mandate that they collaborate with universities. Based on the achievements to date this seems like a program that could increase R&D and innovation in the Australian economy, though it is not apparent what role universities would/should play in this.

Canada’s Strategic Innovation Fund

The Strategic Innovation Fund's (SIF), launched in 2017, allocates repayable and non-repayable contributions to firms of all sizes across all of Canada's industrial and technology sectors. SIF’s objective is to spur innovation for a better Canada by providing funding for large projects (over $10 million in requested contribution). The program serves to simplify application processes, accelerate processing, and provide assistance that is more responsive and focused on results.[19] In Dec 2020, the new SIF Net-Zero Accelerator was launched to fund decarbonization projects with large emitters, scale-up clean technology and accelerate Canada's industrial transformation across all sectors.The Strategic Innovation Fund covers all sectors of the economy and is available to for-profit and not-for profit organizations with the goal of supporting the Canadian innovation ecosystem. The program has two broad components:

- Business Innovation and Growth (Streams 1 to 3)
    - Encourage research & development (R&D) that accelerate technology transfer and commercialization of innovative products, processes and services,
    - Facilitate the growth and expansion of firms in Canada, and
    - Attract and retain large-scale investments to Canada.
- Collaborations and Networks (Streams 4 & 5)
    - Advance industrial research, development and technology demonstration through collaboration between the private sector, researchers and non-profit organizations, and
    - Support large-scale, national innovation ecosystems through high impact collaborations across Canada.

Funding

There have been 81 projects and $2.9 billion in SIF contributions to date. SIF funding is open to all regions across Canada and across all sectors. On November 30, 2020, the Government of Canada announced that the SIF would invest $250 million over 5 years to support Canada's innovative, intellectual property-rich firms. Through its continued support of large-scale transformative projects, the SIF will support Canada's most innovative firms and industries weather the

pandemic and grow into world leaders that will help drive growth and create jobs in the Canadian economy.

On December 11, 2020, the Government of Canada announced that it will be investing $3 billion over 5 years through SIF's new Net Zero Accelerator fund to rapidly expedite decarbonization projects with large emitters, scale-up clean technology and accelerate Canada's industrial transformation across all sectors.

Progress

Below is an investment snapshot of SIF as of March 2021. There were:

- 81 announced projects;
- $2.9 billion in SIF contributions;
- $45.5 billion in total investment leveraged; and
- 70,000 jobs created and maintained.

Short summary of performance

This program is entirely designed to promote innovation amongst the private sector in targeted areas and has no mandate that they collaborate with universities. Based on the achievements to date this seems like a program that could increase R&D and innovation in the Australian economy, though it is not apparent what role universities would/should play in this.

New Zealand PreSeed Accelerator Fund

The PreSeed Accelerator Fund (PASF), which was first made available by the NZ Government in 2003 and supports early-stage technology commercialisation activities which[20]:

- maximise the commercial benefits to New Zealand from publicly funded research;
- improve the commercial capability and skills of public research organisations;
- promote linkages between public research organisations and potential private sector partners, including industry players and capital providers, in New Zealand and offshore.

PreSeed works alongside the Commercialisation Partner Network (CPN). CPN builds capability and PreSeed provides project funding. The goal of the PSAF is to support publicly funded research and development projects to attract private investment. The Fund is a devolved fund. Working with a Commercialisation Partner Network Investment Committee, successful applicants will use PreSeed funding to progress their chosen commercialisation projects to investor readiness. To apply for PreSeed funding, you must be either a public or not-for-profit private New Zealand research organisation with a regular and demonstrated flow of eligible commercialisation projects. A research organisation is defined as a New Zealand legal entity that has internal capability for carrying out research, science or technology or related activities. Eligible New Zealand-based organisations include but are not limited to:

- Crown Research Institutes;
- universities, wānanga, and polytechnics;
- District Health Boards;
- majority owned subsidiaries of eligible research organisations;
- collectives of eligible research organisations; and
- not for profit private research associations.

In 2016, the NZ Ministry of Business, Innovation and Employment (MBIE) proposed a number of changes to PSAF to make it more effective by[21]:

- broadening the utility of PreSeed to all publicly-funded contestable research;
- making it easier for projects to protect their IP;
- gathering better data about the performance of the innovation system; and
- helping PreSeed contract holders to manage their funding flows.

The 2014 "PreSeed Accelerator Fund Outcomes-10 Year Review"[22] report summarises data collected from fifteen New Zealand research organisations that in total invest the majority of the government's PSAF. The evaluation report found that:

- The fifteen organisations in the report invested a total of $42.6 million of PSAF over the ten-year period from 2003-2013. This was matched with a further $90.9 million of co-funding from research organisations and external investors. This adds up to a total of $133.5 million invested into 573 PreSeed projects over the period.
- These projects had resulted in excess of 386 commercial deals and had returned $188.2 million of actual revenue back to the research organisations, over four times the government PSAF contribution.
- PreSeed projects had generated over 460 jobs, some temporary and some permanent, and had estimated potential to generate export revenues of up to $3.0 billion.

Funding

In the 2019 investment round the NZ Government invested $17,994,920 over two years to advance commercialisation projects to a point of investor-readiness. This included the $1,566,000 per year increase for CPN and PreSeed that was announced in Budget 2019.

The successful PSAF applicants in the 2019 round were:

- Auckland UniServices Ltd is the commercial research, knowledge transfer and custom education company of the University of Auckland - dedicated to connecting the University's capabilities to business and investors, Government and the community.
    - Auckland Uniservices Limited was approved for funding of $5 million (excluding GST) over two years.

- Kiwi Innovation Network Ltd (KiwiNet) will deliver a new PreSeed Accelerator Fund (PreSeed) programme that will drive a suite of commercial prospects emerging from publicly-funded research to market, to transform NZ's economy from high-volume to high-value. This will drive forward a globally-competitive technology sector in NZ. KiwiNet is the combined power of 18 of NZ's Universities, Crown Research Institutes and other research organisations who receive public funding, representing a total combined research expenditure of over $800 million and over 80% of NZ's publicly-funded researchers.
    - KiwiNet was approved for funding of almost $10 million (excluding GST) over two years.
- New Zealand Forest Research Institute Ltd (Scion) core purpose is to drive innovation and growth from New Zealand's forestry, wood products, wood-derived materials and other biomaterial sectors, to create economic value and contribute to beneficial environmental and social outcomes for New Zealand.
    - Scion was approved for funding of just over $1 million (excluding GST) over two years.
- Otago Innovation Limited a subsidiary company of the University of Otago, and has the primary responsibility for maximising the commercial value of the University of Otago's research outputs.
    - Otago Innovation Limited was approved for funding of $2 million (excluding GST) over two years.

Progress

Over the next two years (2019-21), KiwiNet, and the University of Auckland's national commercialisation programme, Return On Science, will use this PreSeed investment to take world-leading innovations to market.

Since its inception, *Return On Science*[23]*:*

- Has made sure 77% of pitches result in commercial deals
- It has supported 60 start-ups like PowerbyProxi, Engender, and Objective Acuity
- It has generated more than $200 million in revenue for the innovation economy
- KiwiNet has already delivered:
- Technologies and companies which have generated $293 million revenue to Kiwi businesses and research organisations

- 383 commercial deals and $428 million potential export earnings
- Supporting the creation of 39 start-up companies like Hot Lime Labs, Invert Robotics, Zeakal and Ligar.

Together KiwiNet and Return On Science are responsible for creating over 300 jobs across the country.

Short summary of performance

The returns under this program are currently relatively modest in scale – the program has had a small commercial return relative to investment ($42.6 million PSAF investment and $188.2 million of revenue back to research organisations over ten-years). It has also relatively modest leverage of its funding ($90.9 million of co-funding from research organisations and external investors). Unsurprisingly this has had a small impact on job creation (460 jobs). It would seem that this is not a scalable program that will have widespread economic impacts in the long term.

USA’s Small Business Innovation Research Program

The Small Business Innovation Research (SBIR), established in 1982, and Small Business Technology Transfer (STTR), established in 1992, are highly competitive programs that encourage domestic small businesses to engage in Federal Research/Research and Development (R/R&D) with the potential for commercialization. Through a competitive awards-based program, SBIR and STTR enable small businesses to explore their technological potential and provide the incentive to profit from its commercialisation.[24] The Small Business Administration (SBA) serves as the coordinating agency for the SBIR and STTR programs.

The mission of the SBIR/STTR programs is to support scientific excellence and technological innovation through the investment of Federal research funds in critical American priorities to build a strong national economy. By including qualified small businesses in the nation's R&D arena, high-tech innovation is stimulated, and the United States gains entrepreneurial spirit as it meets its specific research and development needs. The program's goals are to:

- Stimulate technological innovation.
- Meet Federal research and development needs.
- Foster and encourage participation in innovation and entrepreneurship by women and socially or economically disadvantaged persons.
- Increase private-sector commercialization of innovations derived from Federal research and development funding.

In addition, the STTR program aims t foster technology transfer through cooperative R&D between small businesses and research institutions.Both the SBIR and STTR programs have three phases:

- Phase I funds feasibility-related R&D related to agency requirements.
- Phase II supports further R&D efforts initiated in Phase I that meet particular program needs and exhibit potential for commercial application.
- Phase III is focused on commercialization of the results of Phase I and Phase II grants; the SBIR and STTR programs do not provide funding in Phase III.

Each year, Federal agencies with extramural R&D budgets that exceed $100 million are required to allocate 3.2% (since FY2017) of this extramural R&D budget to fund small businesses through the SBIR program. Federal agencies with extramural R&D budgets that exceed $1 billion are required to reserve 0.45% (since FY2016) of this extramural R&D budget for the STTR program.

Currently, eleven Federal agencies participate in the SBIR program and five of those agencies also participate in the STTR program.

- Five federal agencies with large extramural research budgets provide both SBIR and STTR awards and collectively fund 97.5 percent of the program:
    - the Department of Defense (DOD),
    - Department of Energy (DOE),
    - Department of Health and Human Services (HHS),
    - National Aeronautics and Space Administration (NASA), and
    - The National Science Foundation (NSF).
- Six other agencies fund the remaining 2.5 percent of the program, providing SBIR awards but no STTR awards:
    - the Department of Agriculture,
    - Department of Commerce,
    - Department of Education,
    - Department of Homeland Security,
    - Department of Transportation, and
    - Environmental Protection Agency.

To be eligible for SBIR, an applicant must qualify as a small business concern (SBC). An SBC is a for-profit entity with a place of business in the United States, over 50 percent U.S. ownership, and no more than 500 employees.
The SBIR and STTR programs have been extended and reauthorized several times since their initial enactments. In 2016, the programs were extended through September 30, 2022, by the National Defense Authorization Act for Fiscal Year 2017.[31] Among its provisions, the act extended (through FY2022) the pilot programs authorizing the use of SBIR and STTR funds for:

1. administrative costs, outreach, and contract processing activities, and
2. technology development, testing, evaluation, and commercialization assistance.

This required the Department of Defense (DOD) to create a pilot program to accelerate the process for awarding SBIR and STTR awards; and required federal agencies with SBIR and STTR programs to establish a Commercialization Assistance Pilot Program.

An evaluation of the National Science Foundation (NSF) SBIR program from 2019[25] found that:

- Over the past two decades, the NSF reinvented its SBIR program to specifically target growth-focused start-ups and to emphasize commercializing innovations derived from federal R&D.
- Other agencies should follow NSF's model and do more to target growth-focused companies, centralize program management, hire dedicated program directors, and coordinate SBIR awards with other agency programs that provide support for commercialization.
- Congress should reform SBIR funding to grant agencies more autonomy, require agencies prioritize commercialization potential in funding decisions, allow awardees to use funds for commercialization activities, and increase federal funding for R&D.

Funding

Five major agencies fund the vast majority of all SBIR/STTR awards:

- Department of Defence ($1.8b)
- Department of Health and Human Services ($1.15b)
- Department of Energy ($308m)
- Natuional Science Foundation ($212m)
- NASA ($183m)

In total, the budget for FY2019 was $3.8 billion in SBIR funding and $453 million in STTR funding.

Through FY2017, federal agencies had made more than 166,000 awards totalling $47.9 billion under the SBIR and STTR programs of which for FY2017 there was $2.6 billion in SBIR funding and $365.3 million in STTR funding.

Progress

Since inception through to FY2019, over 179,000 awards have been made channelling more than $54.3 billion of public funds to private businesses under the SBIR and STTR programs. In FY2018, federal agencies awarded nearly 6,000 SBIR awards to over 3,000 SBCs.

The figures below show the progress of the SBIR program since 1990. It shows the award and obligation amount timeline for participating agencies over the time period 1990-2017. This included:

- FY2017 there were 5,094 SBIR awards totalling more than $2.6 billion in funding;
- FY2016 there were 4,501 SBIR awards totalling more than $2.3 billion in funding;
- FY2015 there were 4,324 SBIR awards totalling more than $2.2 billion in funding;
- The obligation funding amount has seen a steady increase since the 1990's from $460 million in funding in FY1990 to more than $2.6 billion in FY2017;
- The number of awards has seen a smaller rate of increase since the 1990's with a high of 6,651 awards in FY 2006 and an average of around 4,500 awards per year.

Evaluation of the economic impact of SBIR is summarised below[26]:

- Department of Defence provides the latest estimate the impact of their SBIR program, at 22:1 ROI, including $121 billion in sales of new products and services; $347 billion in total economic impact nation wide; and 1,508,209 jobs.[33]

Short summary of performance

The economic impact of this program appears to be vast. However, it is important to remember that this is based on a model of government procurement of R&D that does not exist in Australia as it does across the participating agencies and departments in the USA (including the Department of Defense, Department of

Energy, Department of Health and Human Services and National Aeronautics and Space Administration). This is a fundamentally different approach to government procurement rather than simply an innovation program.

Table 8 Summary of comparator programs

Program	Public/private sector	Succeeding/Failing (and reason)	Recommended for Australia?
UK Grand Challenges	Both	Failing. The program is not leveraging sufficient private sector investment.	No. There is no evidence that the program is succeeding at this stage.
UK Catapult Network	Both	Failing. It lacks scale to meet its ambitions and has fostered low links between universities and industry.	No. It is not succeeding at present and is not addressing the key issue of research translation and collaboration.
Japanese Moonshot Research and Development Programme Missions	Private	Too soon to tell.	No. In Japan the research workforce is largely employed in private enterprise not inside of universities.
Australia Low Emission Technology Statement	Both	Too soon to tell.	No. It is too soon to understand if the program is effective and also difficult to imagine how it could be rolled out in other sectors.
Canada Industrial Research Assistance Program	Private	Succeeding. Recently evaluated by KPMG and is meeting objectives.	Yes. It is aimed at SMEs in an economy that is similar to Australia's with a similar research workforce.
Canada Strategic Innovation Fund	Both	Succeeding. It is deriving large leveraged investments from industry.	Yes. It is aimed at SMEs in an economy that is similar to Australia's with a similar research workforce. It has a specific stream for driving collaboration across private and public research sectors.
New Zealand PreSeed Accelerator Fund	Both	Succeeding. It is deriving small scale returns.	No. It is a very small program and is not clear that it is scalable.
USA's Small Business Innovation Research Program	Private	Succeeding. It is generating large ROI for participating departments and agencies.	No. It is based on a model of government procurement of R&D that is not possible in Australia.

Notes

1. Note: industry GVA at basic prices as a proportion of total GVA at basic prices. Source: Australian Bureau of Statistics, Australian System of National Accounts 2019-20 financial year
2. Source: Australian Bureau of Statistics, Counts of Australian Businesses, including Entries and Exits July 2016 - June 2020
3. Ibid
4. Ibid
5. This is different from producing new knowledge which enterprise dos, also, but which does not seem to be factored into the current consultation paper.
6. Source: Australian Bureau of Statistics, Research and Experimental Development, Businesses, Australia 2017-18 financial year
7. This is in terms of relative absorptive capacity, only and doesn't consider trends – for example, Professional, scientific and technical services recorded the largest increase (up 36%) followed by Manufacturing (up 18%), while, Mining and Financial and insurance services recorded the largest decrease, down 44% and 11% respectively. These are important considerations.
8. OECD Science, Technology and Industry Scoreboard 2017
9. OECD Science, Technology and Industry Scoreboard 2013
10. OECD Science, Technology and Industry Scoreboard 2017
11. Australian figures are provided by ABS Research and Experimental Development, Businesses, Australia
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