ACTON INSTITUTE FOR POLICY RESEARCH AND INNOVATION

Investing in Australian public research and development

Problems, challenges, and opportunities

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Preface

This Paper was first written in 2022 as a Howard Partners project during the COVID-19 period. It followed the completion of the UTS Occasional Paper Challenges for Australian Research and Innovation (Howard, 2020) and several other projects for the Commonwealth Department of Education.

The Paper reflects on 25 years of working as a policy analyst, researcher and adviser in Australian science, research and innovation (SRI) policy. Specifically, it reflects knowledge and experience gained from working in a broad range of roles in business, government and higher education organisations. These roles have involved hundreds of hours of consultations with people in universities, public research agencies, small, medium and large enterprises, businesses, business organisations and government.

Not everyone will agree with the reflections and observations in the Paper, and some comments may be considered provocative or unsupported by evidence. However, the aim is to promote thought and consideration of options for institutional change and improvement. In these respects, discussion and debate are always welcome.

Much of the statistical data in the Paper has been revised and updated, but the essential narrative of the Paper stands. The Paper is being released now in the context of the Government's decision to commission a strategic examination of Australia's R&D system to "determine how we can get more value from every taxpayer dollar invested in research, maximise the contribution of science and R&D to the broader economy, and maintain our competitive edge"[1]

Some, but by no means all, of the issues raised in the Paper have been addressed in policy and budget decisions over the last two years. Many issues reflect deep-seated institutional attitudes, beliefs, and behaviours within and between the "pillars" of business, government, and higher education, which reflect a historical economic and socio-cultural context.

Quick fixes, buzzwords, and aspirational rhetoric cannot sustainably address deep-seated challenges and opportunities. These approaches have been tried many times but generally don't work.

Initiatives that have lasted for an extended period reflect a serious commitment to the "scientific method" of hypothesis building, testing (with data, documentary evidence, and expert opinion), considering options and alternatives, and drawing conclusions to deliver recommendations.

This Paper suggests that the issues and challenges should be addressed in a *National Research and Development Policy White Paper* that sets out missions, challenges, plans, objectives, and implementation details, defines responsibilities and accountabilities and contains meaningful performance measures. The Paper should have a ten-year time horizon at least.

The *White Paper* process should replace the ongoing and steady stream of announcements, actions, intentions, and reviews relating to program initiatives, often contained in glossy brochures and booklets. The *White Paper* should acknowledge the missions and strategies of State and Territory governments.

Dr John H Howard
Canberra
May 2024

[1] The Hon Ed Husic MP, 2024. "Industry, science and technology powering Future Made in Australia", https://www.minister.industry.gov.au/ministers/husic/media-releases/industry-science-and-technology-powering-future-made-australia#:~:text=Our%20%2422.7%20billion%20Future%20Made,and%20great%20well%2Dpaying%20jobs.

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Introduction

The Australian public research investment system is in disarray. It has evolved over 70 years since the formation of the Tertiary Education Commission in 1953 with a stream of multiple and disconnected decisions taken by 47 different Ministries (14 Prime Ministers), a multitude of Ministers, and a plethora of departments and agencies.

State governments have also had a disconnected approach to research investment depending on election cycles and priorities of Premiers and Ministers with varying responsibilities for science, research, technology and innovation.

This discontinuity has resulted in a complete absence of any long-term vision, strategy, or commitment about how Australia wants to go about investing in public research and development, including:

- building and diversifying its science and research base
- growing its knowledge organisations and the way they will be funded over the medium to longer-term
- how a research and development workforce will be educated and trained
- how the essential facilities and equipment (the tools of research) should be provided, maintained, and sustained.

Because the Australian Government has no constitutional responsibility for science and research, these responsibilities essentially reside with the States (except in Defence, External Affairs, and Quarantine functions). The Commonwealth's only real power is to provide money to the States (Section 96 of the Constitution) or to fund organisations under its general appropriation power (to provide money for the purposes of the Commonwealth). These are very clumsy policy instruments.

For many years, up to and after Federation, the States carried the burden of agricultural research (particularly farming) and public health research. In the medical area, not-for-profit organisations predominated and were funded extensively through philanthropy.

The Commonwealth can and has created research organisations as part of its machinery of Government in response to policy concerns at the time. Some fall within departmental remits (DST Group, Antarctic Division, Geoscience Australia, Office of Defence Production, CSL), statutory (CSIRO, ANSTO) and others may be public organisations (ANU).

Many of the public research organisations created in the early part of the last century were public corporations and privatised during the New Public Management era of the late 1980s and 1990s (CSL in 1994, ADI corporatised in 1989 and privatised in 1999 to become part of French conglomerate Thales).

The States have created their universities as public organisations, each operating under their own statutes. The Commonwealth funds them through financial assistance under the *Higher Education Support Act* as well as grants, and payments for student tuition (teaching and learning) through HECS/HELP.

Universities generate funds through other student payments (particularly international students), other designated government grants for specific purposes, and revenues from a diverse range of other income categories, including financial, property, and business enterprise investments.

"Profits" made on teaching and learning are regarded as internal funds available for research—sometimes referred to as the "teaching surplus." ABS data indicated that universities fund about half of their research from "internal funds" – a drop from 60% 30 years ago. Teaching has become less profitable over the years as student numbers have increased and the real value of financial assistance grants declined.

The Commonwealth began providing research funding through the Australian Research Grants Committee in 1965, now the Australian Research Council. Universities can apply for funding through the NHMRC, the Rural RDCs, and a wide range of other Commonwealth and State departmental funding programs. Some of these programs, such as DESE block grants, are formula-driven. Others are determined by grant "criteria" and Ministerial discretion.

However, the Commonwealth does not "control" universities except that it can make rules and directions under powers referred to by the States (as under TESQA) and through its defence, foreign affairs, and corporations powers.

With this short background, the situation in SRI funding policy is probably worse than any other area of public administration and policy, apart from Health, where there is continual friction between the Commonwealth and the States, reflected most recently in the aged care sector.

The SRI system can be characterised in the following terms:

- There is little understanding, or "corporate memory", among Commonwealth Ministers and their advisers about how the SRI system actually works – with the important exception of agriculture, particularly farming.
- There is little apparent coordination across Commonwealth portfolios. There isn't a research, science, and innovation committee of cabinet, and there is little formal coordination between the Commonwealth and the States, except in Agriculture.
- Functions constantly shift between ministerial portfolios as Governments change and ministerial reshuffles take their course, creating an absence of policy continuity and priority. The Administrative Arrangements Order promulgated after each Cabinet reshuffle is an outcome of political bargaining, compromise, and bureaucratic powerplays rather than an instrument of good public administration.
- The political strengths and weaknesses of Ministers in the Cabinet hierarchy and their commitment impact the resources allocated to SRI.
- There are mixed and changing policy connections between SRI and education and industry; SRI is dominated by education in the education ministry and by industry in the industry ministry. The link between education, SRI policy, and funding is fraught, reflecting fundamentally different cultures between the two domains.
- There is little apparent connection between institutions in the system—between HE, government research, and NFPs; partnerships emerge when money is available.
- The evolution of the system has been influenced by changing economic ideologies—for example, those about the role of public research and its interaction with the market and concepts of "market failure".
- Multiple reviews and policy statements have been issued over the past 25 years, particularly, often repeating the same messages but with little accumulated knowledge.
- Science and research are coming into and out of favour, e.g., the rise and fall of Science Minister Barry Jones.
- A strong emphasis on applied research and commercialisation.
- Policy changes on the run as fiscal austerity demands it.
- Continuing policy overlays – new policies that duplicate what is already in place rather than building on success. For example, could the Research Commercialisation Action Plan achieve its goals by building on the CRC program – which focuses on research commercialisation – and has strong links with industry and universities?
- Overlapping policy initiatives – the most recent in the apparent overlap between responsibilities for research commercialisation between the Department of Education and the Department of Industry, Science and Resources.

- Administrative and bureaucratic silos—a built-in feature of the Australian system of public administration, budgeting, and finance.

Perspectives have been essentially short-term and tactical. There has never been a national research foundation.

The result is that too little money is spread across multiple ministries, departments, and agencies through a plethora of channels (programs) as the demand for new knowledge, insights, discoveries, and inventions informed by science, research, and innovation (SRI) increases. This is a fundamental system failure, distorted by an absence of mission and focus on money—or lack of it.

Some threshold questions emerge:

- Why do we have 43 universities receiving public funds for research? Although public funding is heavily concentrated in 10 universities, why should small universities feel obliged to waste time preparing competitive grant applications with little or no chance of success?
- Why shouldn't public research organisations be able to access funding schemes that are only available to universities (although there are, in fact, only a few of these)?
- Why has the Commonwealth prioritised funding public research through universities rather than through its own public research organisations?
- Why is comparatively more public money allocated to medical research?
- Why were the States allowed to reduce their commitment to agricultural research with the availability of RRDC funds?
- Why aren't high-performing CRCs encouraged to grow after CRC funding runs its course?
- Why is the CRC program regularly cut to make room for another similar policy initiative?

Restoring and repairing Australia's public research system will take time. It requires a long-term commitment and vision. Partial and incremental solutions will not work. A "root and branch approach" is needed.

But do our political leaders and their advisers see the problem and the risks to Australia's knowledge future and have the fortitude to fix it? The problems have been apparent for 25 years. Will we still be canvasing the same issues in another 25?

1 The context

Over the last ten years, the research funding system, and public policy more generally, has taken on a perception of "Policy by Announcement" (Howard, 2020). Announcements now carry with them a very low public expectation that anything will ever happen or be delivered. Ministers change their minds, the funding shifts to another announcement, or it merely never materialises through the budget.

Almost always, announcements are built around a promise of a large amount of money. Examples of 2022 announcements include:

- 27 January 2022: $14m for a Defence research precinct in Brisbane (Minister for Defence, 2022).
- 28 January 2022: $1 billion to save the Great Barrier Reef, *to be spread over nine years*, for extending existing scientific work to protect the reef and its wildlife (Australia. Prime Minister et al., 2022).
- 22 February 2022: $804.4 million *over the next ten years* to strengthen Australia's strategic and scientific capabilities in Antarctica (Australia. PrimeMinister, 2022).
- 25 February 2022: $65 million into the Australian Space Agency to get Australian technologies into space sooner and to make Australia a leading destination for launch (Australia. Prime Minister, 2022).

Of particular significance in the science research and innovation domain was the announcement by the Acting Minister for Education and Youth on 31 January 2022 that the Government would provide $2.2 billion for *an 11-year University Research Commercialisation Action Plan* that would focus on priority areas of economic need (Department of Education Skills and Employment, 2022).

The *Action Plan* encompassed $1.6 billion for "Australia's Economic Accelerator" (with a further $150,000 for CSIRO Main Sequence Ventures), $296m to fund 1,800 PhDs and fellowships in industry-focused disciplines, and $243m for the *Trailblazer* program announced in November 2021 (Prime Minister, 2021).

The documentation behind the announcement reflects an enormous amount of work undertaken by a Working Group in the Department of Education Skills and Employment (DESE), consultation and engagement with constituencies, and the effort provided by people and organisations to make submissions and attend meetings and workshops.

This level of commitment is often at odds with the commitment behind many other policy and program announcements. The present Government's continued implementation of the key elements of the Action Plan is a credit to it.

The recent announcements for the *National Reconstruction Fund* and the *Future Made in Australia initiative* do not involve a substantial R&D commitment. The success of these initiatives may be contingent on being able to "pull through" the outcomes of R&D undertaken in Australia's public research system.

Unfortunately, there are many examples of ambitious plans and strategies that were established with much fanfare, only to be cut short due to budgetary considerations. These include, for example*, Backing Australia's Ability* (2004), the *Education Investment Fund* established in 2009 (incorporating the *Higher Education Endowment Fund* established in 2007), and the *National Innovation and Science Agenda* (NISA) established in 2015.

However, there is a broader issue about the extent to which the higher education sector should be expected to do the "heavy lifting" in research commercialisation specifically and in the nation's R&D effort more generally.

Over the last 30 years, there has been a discernible shift towards applied research and away from basic research. Many in the higher education sector and the broader community do not see this as a good thing.

Approaching these issues, as outlined in this Paper, will be controversial. However, change is essential for the public research system to meet the expectations being placed on it. A good starting point would be the complete separation of funding streams for higher education teaching and learning (T&L) from funds for research.

This would set the scene for a substantial increase in the allocated resources for public research that builds specialisation, scale, complementarity, collaboration, and partnership. It would also allow the regulation and extension of teaching and learning in the broader higher education sector overseen by TESQA to continue without compromise.

2 Strategic issues

2.1 Public research has a big job to do

Public research is crucial in an advanced economy that aims to raise and sustain rising living standards, capture economic opportunities, and deliver social justice. *Research that drives advances in science, technology, and innovation is key to knowledge-driven value creation and productivity*.

Australia's public research effort is undertaken across multiple research organisations that receive funding from a range of sources:

- Grants from research funding councils: the NHMRC (for universities, medical research institutes, hospitals); the ARC (universities only); the Rural Research and Development Corporations (universities, public research organisations – Commonwealth and State).
- Direct departmental appropriations - e.g., Department of Education block grants, funding programs from the Department of Industry, Science and Resources, the Department of Climate Change, Energy, the Environment and Water, the Department of Agriculture Fisheries and Forestry, Department of Health and Aging, and numerous other departmental research funding programs (available to universities, public research organisations, and private researchers).
- State/territory governments, business organisations and private philanthropy.
- Internal funding – amounts available from Commonwealth general financial assistance for teaching and research, the higher education loan program, and international students - after teaching and learning costs have been met.
- The financial markets—short and long-term borrowing, sale and leaseback, and public-private partnerships.

Research is undertaken by *people—a workforce that consists of experienced and early career academics, PhD candidates, and postgraduate students, supported by technicians and research assistants. Research supports people in their jobs and provides for their livelihood through permanent and casual employment. PhD students are paid stipends, which sometime*s are well below the poverty line.

The result is that the research workforce, particularly in universities, is highly transitory. Nonetheless, the performance of the public research system and the broader national R&D effort relies heavily on postgraduate students.

ABS data shows that in 2022 (the last year for which data is available), over 55% of the research workforce was constituted by postgraduate students, with a growing proportion from overseas. The academic proportion of the research and development workforce has grown little over the last few years. The lack of growth in the research workforce places a major constraint on extending Australia's national R&D performance.

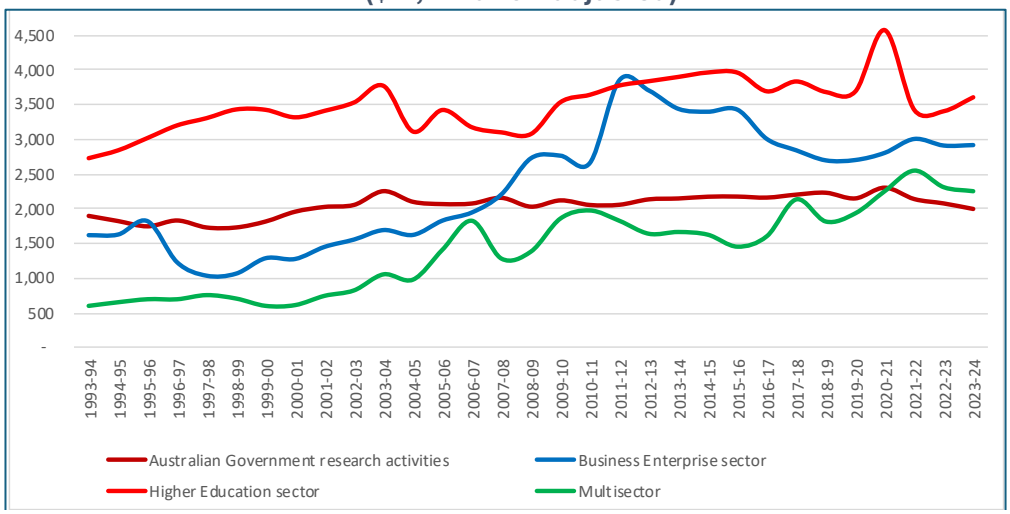
Research is supported by facilities and equipment, technology, and *organisations* that set objectives, allocate resources, and account for performance. It relies on *social capital* to support collaboration, cooperation, and the creation of trust among people within and across organisations. Social capital is regularly called the glue that keeps the system together.

Available funds to support investments in these areas are in short supply, particularly since the winding down of the Education Investment Fund. Shortages vary across research fields, sectors, and organisations within sectors. NCRIS has filled a gap, but the funding is constrained.

2.2 The current research investment sectoral allocation model

The long-term trends in Government inflation-adjusted R&D sectoral investment since 1993-94 are shown in Figure 1.

Figure 1: Australian Government investment in R&D by sector 1993-94 to 2023-24 ($m, inflation-adjusted)



Source: SRI Budget Tables

Figure 1 shows that investment in business R&D substantially increased from 1993-94. However, since 2012-13, the level of investment has been falling mainly due to changes in eligibility for the R&D Tax Incentives (RDTI) program. There was some increase from 2021-22, reflecting measures to improve access to the program by small to medium businesses.

Figure 1 also shows wide fluctuations in the level of Government investment in the higher education sector. In 2023-24, the investment will be equivalent to the level reached in 2003-04—practically no movement over 20 years. Higher Education institutions are deeply concerned about this unstable level of commitment.

Investment by the Government in its own research activities (principally CSIRO, ANSTO and the DST Group) has barely moved over the period. Internationally, government research institutes and laboratories are essential partners in industrial research, as indicated by the 72 Fraunhofer Institutes in Germany and the 42 Government research laboratories in the USA. The Catapult Centres in the UK perform an important role.

A very large increase in “multi-sector” investment has occurred since 2019-20. This covers the NHMRC, the Medical Research Future Fund (MRFF), the CRCs, Rural R&D, Energy, and Environment investments.

Figure 1 also shows that the funding allocations between organisational categories (sectors) are starting to converge. This would be acceptable if the organisations were to retain their distinctive missions and purposes.

However, there is currently a major concern that higher education organisations are moving into the areas of applied research undertaken by public research organisations—a trend that started with the implementation of the Unified National System (UNS) for higher education in 1989 and was followed by a succession of policy announcements that wanted university research to be “useful” and “interested”.

The higher education sector and the broader science community are also concerned that government pressure on universities to shift their emphasis to applied and developmental research and, more recently, research commercialisation has downplayed the importance of a commitment to discovery research and new knowledge creation.

The pressure for universities to commit more to research commercialisation has been around for 20 years (Howard, 2021). However, only a small minority of universities have had any financial success in research commercialisation. For most universities, the costs of research commercialisation exceed the income received.

This lack of success is attributed to the unwillingness of universities to commit to commercialisation rather than a reality that there is simply not enough research ready to commercialise (investment ready) or commercialisable (absence of markets, customers, and stiff competition, for example).

On the other hand, public research organisations such as CSIRO, established with specific remits for applied research for use in government and industry, have achieved remarkable success with their commercialisation strategies (Upstill & Spurling, 2020).

Arguably, medical research organisations have also been successful in establishing more balanced research portfolios of discovery, application, and commercial use in areas such as immunology, clinical treatments, and medical devices.

All research organisations should aim for a portfolio of fundamental, applied, and developmental research that plays to their differing institutional strengths and specific missions. There is no value in all public research organisations looking the same. Unfortunately, in current circumstances, the structure of a research organisation's portfolio is determined more by available funding than by conscious strategy.

2.3 The shift in university resources from teaching to research

The prevailing dual purpose of the Commonwealth government's financial assistance to universities for both teaching and research, which started 60 years ago with the Australian Universities Commission, is no longer fit for this purpose. Over many years, universities have sought to increase the amounts available for research by reducing their commitment to teaching by decreasing teaching hours and student contact, expanding the employment of casuals, and, more recently, outsourcing teaching to online EdTech providers.

With the cutbacks to general financial assistance that have characterised the system over the last ten years, the amount available for research from this source continues to be squeezed. There has been some compensation through the university block grants program for research training (the Research Training Program and the Research Support Program) and research infrastructure (National Collaborative Research Infrastructure Strategy).

The growth in student numbers under the demand-driven system from 2010 to 2015, and later the international student market from 2014, enabled increased research commitment for most universities. That revenue stream is now under threat.

While research output has increased with the shift of resources from teaching to research, there is an associated concern with low student completion and high attrition rates.

To protect and build the quality of higher education, funds intended for teaching and learning should only be used for those purposes. Similarly, research investment must be placed on a longer-term footing to reflect the longer-term time frames associated with research programs and complex research projects.

2.4 Sustaining government research activities

In addition to 41 universities, the Australian government allocates a substantial level of public research investment to its own government research organisations, with five receiving budgets of over $100m in 2023-24. Table 1 sets out a profile of funding commitments for Government research organisations from 2018-19 to 2025-26.

Table 1: Australian Government research activities 2018-19 to 2025-26 ($m)

Organisation	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26
	Actual	Actual	Actual	Actual	Actual	Estimate Actual	Forward Estimate	Forward Estimate
CSIRO	835	838	961	949	991	1,009	934	945
DST	469	378	442	493	513	483	502	542
ANSTO	243	258	261	263	264	267	265	266
Australian Antarctic Division	114	123	197	216	207	192	209	217
ACIAR	107	108	97	101	102	113	114	116
AIMS	47	38	36	50	62	74	78	83
Geoscience Australia [2]	184	191	171	42	52	31	17	2
BOM Research Activities	16	18	19	19	24	25	25	25

Source: Department of Industry, Science Energy and Resources, Science Research, and Innovation Budget Tables, https://www.industry.gov.au/publications/science-research-and-innovation-sri-budget-tables

The expenditure details in Figure 1 are presented in the current prices, which hide some significant real-term reductions in the budget allocation to these organisations.

It is not always clear how resources are allocated to these organisations and internal government activities and how they interact with other components of the national public research system.

2.5 Conflicting policy goals

The Commonwealth Government's primary public policy focus is economic management, closely associated with public expenditure management and control. The Annual Budget is both a resource allocation mechanism and a fiscal instrument that demands flexibility. This plays out in short-term expenditure promises and commitments, an ongoing search for savings, avoiding budget "lock-in," and regular fiscal austerity packages instituted by Commissions of Audit or Expenditure Review Committees.

The Annual Budget is not a long-term plan – notwithstanding the publication of three-year forward estimates and thousands of pages of explanatory material. The Government stopped producing an annual *Science and Technology Budget Statement* in 2000-01 (which ran into 276 pages).

More expenditure cuts are on the horizon as the Government aims to reduce its deficit arising from the growing commitments to the NDIS, age care, childcare, national security, and defence, as well as the committed tax cuts. Together with changes in the international student market that funds a significant proportion of higher education research, the present public research system is in peril and unlikely to be sustainable without a major policy reset and a national public research investment strategy.

2.6 Responding to causes, not symptoms

To fix the national public research investment system, we must understand it as a whole and appreciate where we have come from – and learn from past mistakes.

We must also respect and promote the value of the "research enterprise" (undertaking) over the medium to longer term for the economy, living standards, social justice, and protecting and preserving our natural capital. The success of the enterprise must be demonstrated, not simply asserted with big, meaningless numbers and glib case studies. It must also be aspirational.

2.7 Sustained public research investment is essential.

Sustained and planned investment in public research is essential if Australia is to shift from a commodity-driven economy, with its focus on minerals, mining, farming, international education, and low-value service industries, to new sources of growth in the sectors of the future built around advanced manufacturing, new materials, the application of scientific

[2] Funding for Geoscience Australia has been shifted to the Australian Space Agency.

knowledge, quantum computing, and digital technologies. *Software and silicon* is the new energy in this endeavour.

Sustained public research investment must also be delivered at scale: it must move away from the plethora of small funding schemes (buckets/barrels of money) that are expensive to administer and access. They encourage researchers to go grant hunting to support their pet projects rather than collaborate on more significant projects. (Green & Howard, 2015a)

The new research investment infrastructure must have dedicated funding streams for basic and applied research and experimental development, quite separate from funding streams designed for teaching and learning purposes and available to a wide range of public research providers.

2.8 A new public research investment strategy is required

A new national public research investment strategy must be established and built around a clearly articulated plan that will drive research performance, human resource development, investments in facilities, equipment and instruments, collaboration, and the allocation of resources where they can deliver the most value over the longer term.

The strategy must cover both university research and research undertaken in public research organisations with regard to their distinctive missions and purposes. Within the university sector, strategies should reflect the differing roles of the large research-intensive universities, the technology-focused universities, the smaller innovative research universities, and the post-Dawkins teaching-oriented universities.

The roles of universities, public research organisations and other organisations in the public research domain are inherently complementary. While there is some collaboration between sectors through research partnerships, particularly in using expensive research facilities, this has been approached pragmatically, usually around funding availability. Apart from the longstanding CRC program, the potential for research partnerships across sectors has never been fully developed. Currently, the CRC program makes up just over two per cent of the national public research effort.

This complementarity between sectors must be developed and applied for a small country like Australia to build research strength. The stimulus will come from assured public investment streams and institutional and organisational frameworks that facilitate collaboration and partnership. Transactional and opportunistic collaboration arrangements for grant applications are rarely sustainable and usually do not work over the longer term.

2.9 A governance and organisational framework that facilitates implementation is essential.

Australian Government investment in public research must be driven by a policy framework that addresses the multiple, often competing, public research goals. It must develop a research investment portfolio across basic, strategic, applied, and experimental development categories.

The investment strategy should *encourage* complementarity between research activities and capabilities between research-performing organisations across the public sector. This investment must also build connections with the private and not-for-profit sectors.

This might be achieved by establishing a National Research Investment Foundation as a statutory body incorporating the best features of the US National Science Foundation, the National Institutes of Health, the Defense Advanced Research Projects Agency (DARPA), and research investment foundations in other nations, including the UK, Canada, and Ireland.

One sizable investment pool should allocate funds across universities, public organisations, and businesses.

This Paper provides backup evidence for reaching this position by providing a narrative of the evolution of public research investment over the 45 years between 1978-79 and 2023-24 and the problems and dysfunctions built in by short-term decision-making and periods of fiscal austerity.

3 The Problem

3.1 Diverse expectations about the role of universities

The Australian economy has evolved from an industrial base to a knowledge-driven system that puts a growing premium on education and demands more sophisticated skills. Australian businesses compete in markets that have become more and more global while using complicated methods that rely increasingly on computers, robots, and artificial intelligence.

This issue has been canvassed extensively in US discussions of the achievements and failures of its research universities (Bok, 2006; Cole, 2016; Crow & Dabars, 2015).

The emergence of the knowledge economy has produced a daunting list of demands on the nation's universities:

- *Governments and industry* want universities to undertake research and transfer discoveries and technologies to drive innovation and creativity
- *Governments also have a more instrumental desire* - they want universities to prepare people for jobs and careers.
- *Employers* seek graduates who can adapt successfully to rapid changes in their jobs, solve problems creatively, work adeptly in teams, interact effectively with diverse colleagues, subordinates, and customers, and be resilient enough to overcome the challenges and risks created by constant economic change.
- *Parents* want their children to possess the qualities they need to obtain good jobs, pursue successful careers, and, above all, live happy and satisfying lives.
- *Citizens worry about the troubled state of democratic politics* and call for university graduates who are conscientious about voting, think carefully about the issues of the day, and take an active interest in the affairs of their communities.
- *Newspaper columnists* and other social commentators, concerned by growing signs that the basic norms of society are eroding, are urging universities to educate young men and women to be sensitive to ethical issues, capable of considering them carefully, and strong enough in character to act according to their principles.

Some of these objectives are ones that universities have long had difficulty in achieving, such as preparing students to be active and informed citizens, teaching them not only to understand ethical principles but to live up to them in practice, and helping them to discover a meaningful and fulfilling purpose for their future lives. Significantly, most of these demands relate to the teaching and learning role of universities rather than the research role. The role of research can become lost in the public debate on these issues.

This observation assists in making the case for the separation of funding for universities' teaching and learning roles from research roles—which will allow for separate debates about the distinct roles that each function performs (see further discussion below).

Australian universities are not under their statutes, specifically tasked to support economic development. However, their perceived role in the knowledge economy and national/regional innovation systems gives high status to the significance of university research in the national/regional innovation effort.

In addressing the national research and innovation effort, universities are part of a broader public research system covering government research organisations/laboratories

(Commonwealth and State) and not-for-profit organisations, such as the 57 medical research institutes. Universities award PhDs to people undertaking research in these organisations.

Governments also provide public support to businesses to undertake research that provides public benefit on the grounds of market failures and national "merit" objectives.

The capacity to achieve expectations is compromised by the chaotic system for funding public research. It reflects the absence of a research strategy, a culmination of short-term decisions made in a budgetary context, and frequent cuts to generate savings to address a continuing state of fiscal stress. The most significant dimensions of the problem are canvassed below.

3.2 The confused relationship between teaching and research roles in universities

In Australia, universities have developed a narrative about how well they are positioned to educate and train people to get a job. Yet, they set out to build their reputation and brand based on their research performance, international standing, eminence, and global leadership in creating knowledge.

This is the essence of the current university business model: students, through their fees and government grants based on student numbers, heavily subsidise the research effort. This model is now breaking down.

In the current climate, only a small number of people will attend university in anything like the traditional sense of the word (Crow & Dabars, 2015). Tradition nevertheless endures – the tradition of the organisation and practices of a particular sector of US [and the UK] higher education: the selective liberal arts colleges and major research universities that represent the "gold standard of American higher education".

A recent appraisal of US higher education argues -

> Academics extol high-minded ideals, such as serving the common good and promoting social justice. Universities aim to be centres of learning that find the best and brightest students, treat them fairly, and equip them with the knowledge they need to lead better lives (Brennan & Magness, 2019).

However, it is often argued that American universities fall far short of this ideal. At almost every level, they find that students, professors, and administrators are guided by a self-interested pressure to make money rather than ethical concerns. They are also driven by government, student and parental demand for work-oriented skills and qualifications.

Numerous critiques have been published over many years, including *Academically Adrift: Limited Learning on College Campuses* (Arum & Roksa, 2011), *Mission and Money: Understanding the University* (Weisbrod et al., 2008), *Academic Capitalism and the New Economy* (Slaughter & Rhoades, 2009), and *Our Underachieving Colleges* (Bok, 2006).

There are, however, some more recent positive outlooks and agendas for change and reform, such as *Higher Expectations: Can Colleges Teach Students What They Need to Know in the 21st Century?* (Bok, 2020), *The Great Upheaval: Higher Education's Past, Present, and Uncertain Future* (Levine & Van Pelt, 2021), *The Fifth Wave: The Evolution of American Higher Education* (Crow & Dabars, 2020), and *Designing the New American University* (Crow & Dabars, 2015)

There appears to be a trade-off between a *global/nationally connected research business* and a *locally engaged vocational and professional teaching and learning facility*. They become connected in the search for talent, which manifests in innovation ecosystems - hubs, precincts, and districts.

This raises a question about the extent to which Australia should continue to model its higher education system on the traditions of the US and UK (the Newman doctrine). Much might be learned, for example, from the German (Humbolt) and Korean approaches.

3.3 Falling commitment to public research

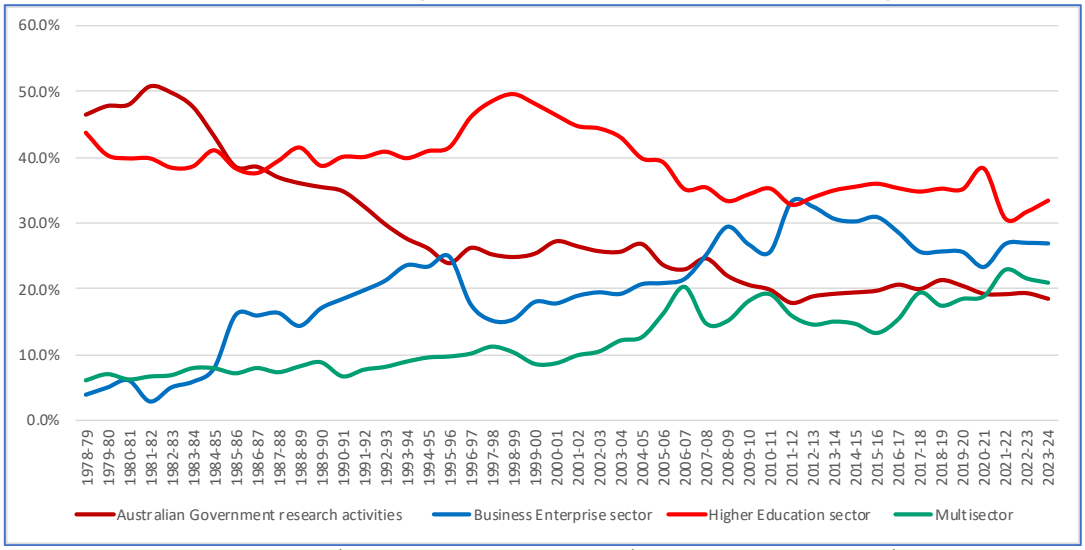
Public research investment covers investments in:

- Higher education research undertaken in Australia's universities (33.5% in 2023-24)
- Research undertaken in Commonwealth government-owned research public research organisations, particularly CSIRO, ANSTO, DST and AIMS (18.4% in 2023-24)

  State governments also invest in their own research organisations and institutes, particularly in agriculture and, more recently, in information technology.
- Research undertaken in "multi-sector" organisations, including medical research institutes established as not-for-profit organisations with links to State teaching hospitals and universities, Cooperative Research Centres (CRCs), Rural R&D Corporations, Other Rural R&D, Energy and the Environment and Other R&D (21.0%).

These proportions have shifted substantially over the 45 years from 1978-79 to 2023-24, with a long-term trend movement towards business research, declining commitments to higher education research, and, most noticeably, a very substantial fall in government research activity (CSIRO, DST, and ANSTO), as shown in Figure 2.

Figure 2: Australian Government Public Investment in Science, Research, and Innovation 1978-79 to 2023-24 (Public, Business and Multi Sectors) %



Source: Department of Industry, Science Energy and Resources, Science Research, and Innovation Budget Tables, https://www.industry.gov.au/publications/science-research-and-innovation-sri-budget-tables

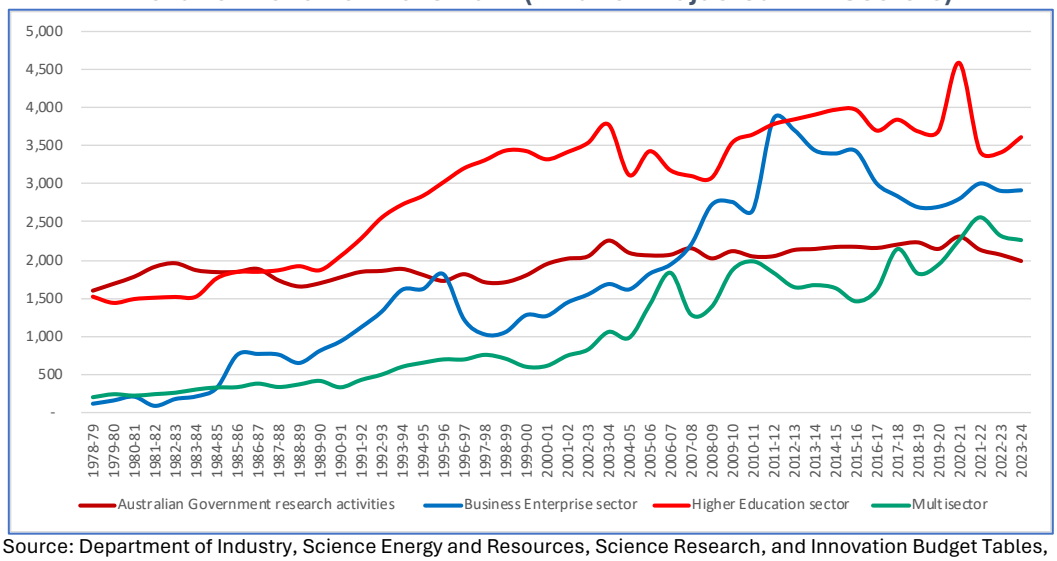
Since 2012-13, there has been a trend reduction in the share of public investment going to business research, most likely driven by changes to the Research and Development Tax incentive. There has been a long-term trend increase in multisector research, most likely driven by the very substantial infusion of funds into medical research.

3.4 The changing balance in the allocation of research investment across sectors

In 2023-24, the Australian Government provided $10.78 billion for investment in science research in innovation (inflation-adjusted, 2020-21 dollars). This included $2.0 billion for government research organisations, $3.6 billion for higher education research, $2.9 billion for business research, and $2.3 billion for multi-sector research.

Figure 3 shows investment trends in these categories and the overall implied priorities in the public research investment system.

Figure 3: Australian Government Public Investment in Science, Research, and Innovation 1978-79 – 2023-2024 (Inflation-Adjusted – All Sectors)



Source: Department of Industry, Science Energy and Resources, Science Research, and Innovation Budget Tables, https://www.industry.gov.au/publications/science-research-and-innovation-sri-budget-tables

Figure 3 shows that over 45 years, the Australian Government has progressively lifted its public research investment in higher education and multisector activities faster than investment in its own research activities (CSIRO particularly). Figure 3 also suggests a convergence of public research investment. Such convergence in the national public research investment system has many benefits in resource allocation *if each sector retains its distinctive missions and capabilities*.

There is, however, a risk with convergence if institutions become isomorphic (corresponding or similar in form and relations). This risk emerges particularly as higher education moves more into applied research and experimental development, predominantly the roles of government research agencies and businesses. However, it is a movement encouraged by governments and is occurring at the expense of basic and strategic research commitment.

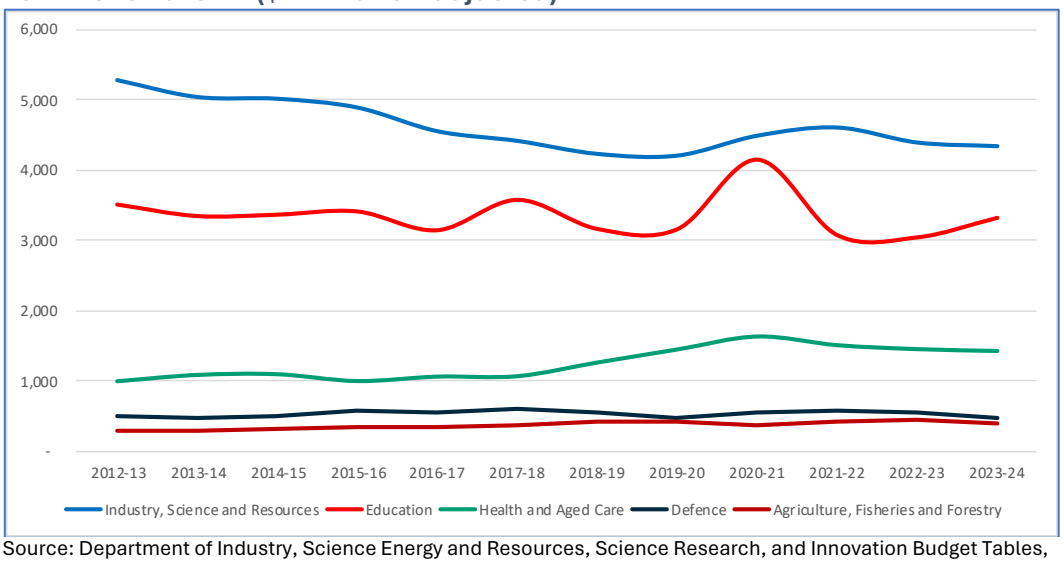
3.5 Dissipation of research investment decision-making across Ministerial portfolios

Australia does not have a national science research and innovation investment strategy. The investment reflects a bottom-up aggregation of multiple funding programs across numerous Ministerial departments and agencies, each with its own decision-making and resource allocation processes.

Past and budget expenditures are aggregated each year into the *SRI Budget Tables* and published halfway through the financial year. While the tables are a very rich source of information, they do not represent in any way an SRI Budget that would reflect the outcome of a plan and resource allocation decisions made by the government as a whole. Moreover, no administrative and organisational infrastructure would enable this to be done.

Intentionally or otherwise, the SRI Budget Tables show a discernible trend shift in Australian Government research investment priority towards the health portfolio and away from the industry, education, agriculture, water and environment, and defence portfolios. There was a small lift in industry portfolio commitment in 2021-22. These shifts are reflected in Figure 4.

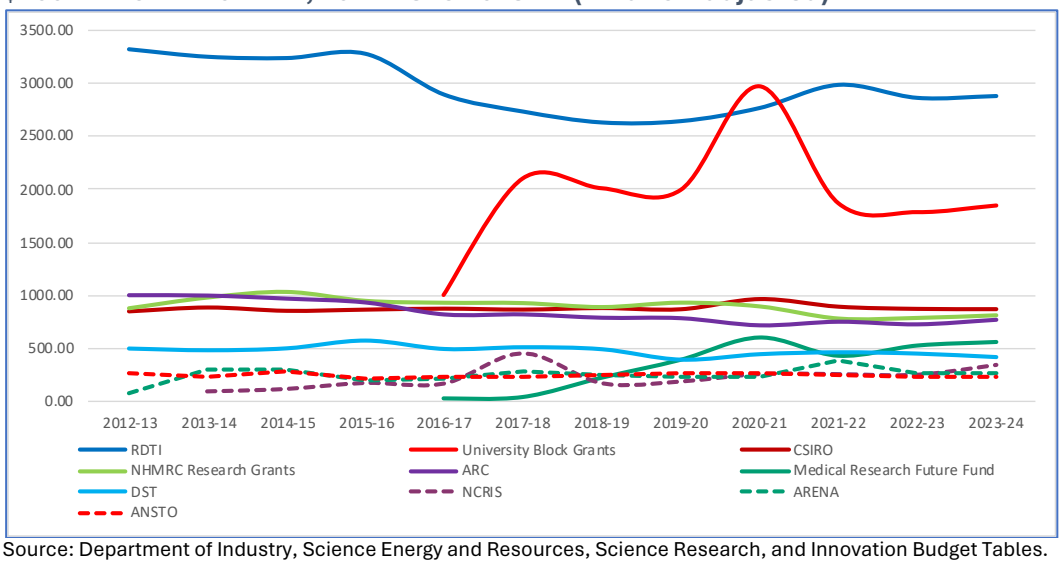
Figure 4: Australian Government investment in R&D by Ministerial portfolio, 2012-13 to 2023-24 ($M inflation-adjusted)



Source: Department of Industry, Science Energy and Resources, Science Research, and Innovation Budget Tables, https://www.industry.gov.au/publications/science-research-and-innovation-sri-budget-tables

This pattern is consistent with the swing away from investments determined by funding councils to departmentally determined programs within the portfolios. This trend is shown in Figure 5 with the declining level of funding for the ARC (shown as the purple line) and increased funding for the DESE Research Block Grant programs (red line) and from the NHMRC (light green line) to the MRFF (darker green line).

Figure 5: Australian Government R&D programs and activities valued at over $200 million in 2021-22, 2012-13 to 2023-24 (inflation-adjusted)



Source: Department of Industry, Science Energy and Resources, Science Research, and Innovation Budget Tables. https://www.industry.gov.au/publications/science-research-and-innovation-sri-budget-tables

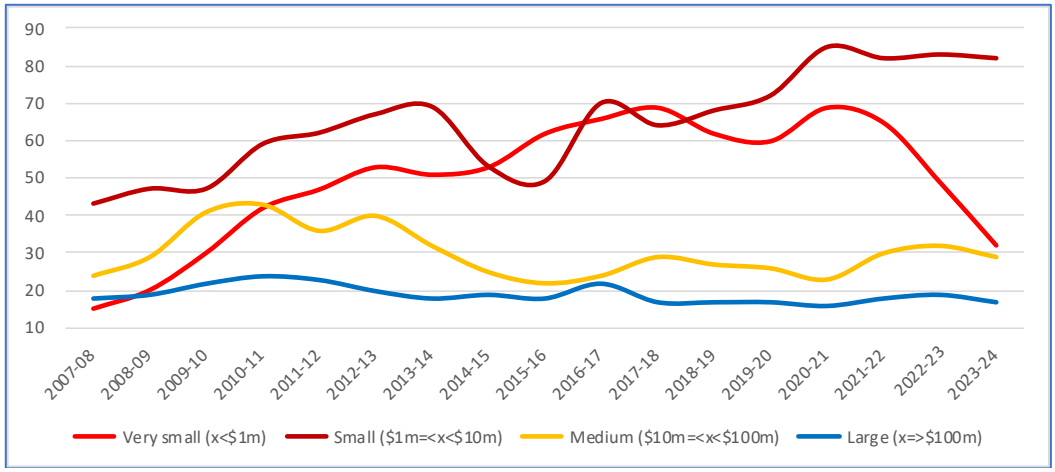
Figure 5 also shows some small growth in funding for the CSIRO in 2020-21 (brown line) but some increase for the DST from 2019-20 (light blue line). There have also been fluctuations in the commitment to NCRIS and the Australian Renewable Energy Agency (ARENA).

3.6 Small programs, small amounts of money

The Australian research investment system is also characterised by many small programs, as indicated in Figure 6 and highlighted in the paper *Challenges for Australian Research and Innovation* (Howard, 2020).

The *Science Research and Innovation (SRI) Budget Tables* show that in 2023-24, the Government will deliver 160 R&D programs. This is down from the 182 reached in 2016-17. Figure 6 shows longer-term trends in the number of programs.

Figure 6: Count of programs/activities by size category



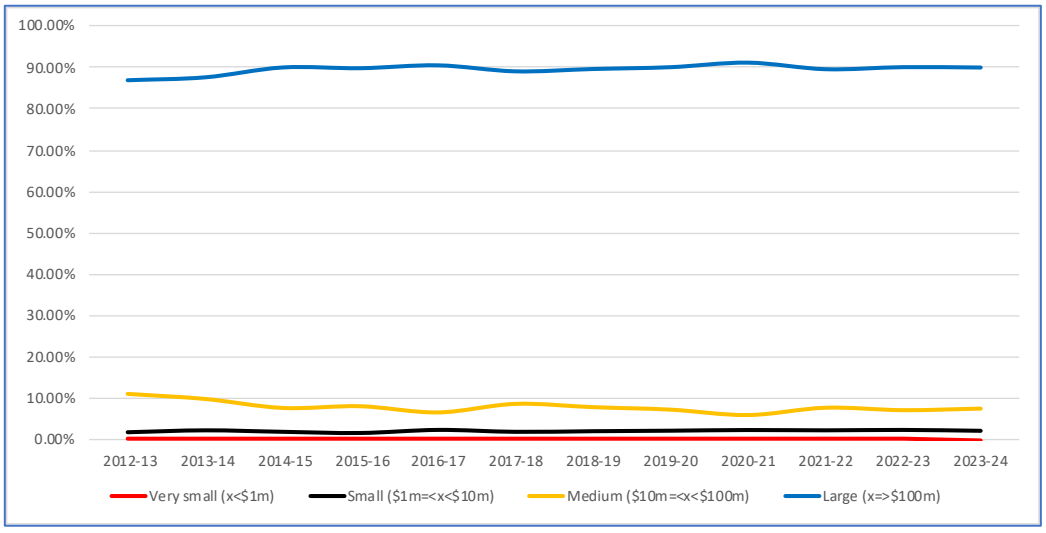
Source: Department of Industry, Science Energy and Resources, Science Research, and Innovation Budget Tables, https://www.industry.gov.au/publications/science-research-and-innovation-sri-budget-tables

The SRI Tables also report that in 2023-24, the proportion of large programs accounted for 89.2% of total investment, the medium ones seven per cent, the small ones three per cent and the very small ones only 0.2%.

The persistence of small programs could be influenced by government agencies wanting to "dip into" the research sector for information, knowledge, and advice rather than commit to a larger program to drive a major research and innovation agenda. Responding to these small "requests for quotation" can be time-consuming and expensive for research organisations.

Nonetheless, the proportion of research investment between the differing size of programs is shown in Figure 7.

Figure 7: Proportion of total investment accounted for by programs/activities per size category 2011-12 – 2021-22



Source: Department of Industry, Science Energy and Resources, Science Research, and Innovation Budget Tables, https://www.industry.gov.au/publications/science-research-and-innovation-sri-budget-tables

3.7 A transactional research culture driven by money

The development of public research investment decision-making has created a research culture driven by money. It is also a transactional culture. Researchers are incentivised and

rewarded for the research income they generate, and small “wins,” particularly in smaller universities, are widely publicised internally.

Postdoctoral students and other non-tenured researchers' continued employment and livelihood depend on securing an ongoing stream of grant income. They are on a never-ending quest for more money to secure their jobs.

Conversely, departments, agencies, and businesses put out requests for quotation (RFQs) for research, assuming that a research workforce is ready, waiting, and eager to take on new commissions.

Competitive tendering is required under government procurement guidelines. An industry of professional grant writers prepares responses to RFQs. There is little opportunity for researchers and research investors to develop close, trust-based relationships. Integrity agencies and Senate estimates committees can interpret getting too close as corruption.

There can be no guarantee under this arrangement that the results by either party can be achieved.

3.8 The overriding influence of public expenditure management and control

Public research investment necessarily involves public expenditure, which is allocated (appropriated by Parliament) through the annual budget process. Accordingly, public research investment decisions and announcements are always framed in terms of how much money will be provided.

Decisions and announcements are never set in stone and can be reversed when fiscal conditions demand expenditure cuts. Public research investment has been more susceptible than most expenditure programs to cuts or elimination through Cabinet Expenditure Review Committee deliberations.

When Ministers are advised of their annual portfolio expenditure ceiling, they will offer cuts where the political damage is lowest. Cuts to public research investment offer a path of least resistance.

Further comments on the distribution of public research investment among sectors follow.

4 Higher Education Research Investment (HERD)

4.1 Overview

The Commonwealth’s commitment to public research investment shows some preference for supporting HERD, but the commitment has been uneven and discontinuous (see Figure 3 above). There was a lift in 1984-85, associated with the new Labor Government's commitment to increase funding to the Australian Research Grants Committee (ARGC), which continued until 1989-90.

The commitment to HERD increased sharply in 1989-90 when, with the introduction of the Unified National [Teaching and Learning] system, funds were shifted from university block grants to the ARGC (the forerunner of the Australian Research Council incorporated in 2001).

The justification for this change was to direct more research activity into project grants awarded on a competitive basis and encourage universities to do more to solicit research funding from industry. As it became known, this ‘clawback’ amounted to $125 million over three years and represented 4.5% of universities’ operating grants (Croucher & Waghorne, 2020).

This was also the beginning of a shift in priority to universities undertaking more applied research rather than supporting their own research agencies in this endeavour.

The transfer effect of funding from teaching and research continued until 2001, coinciding with the incorporation of the ARC, when Commonwealth support dropped and then recovered again

in 2002-03 with the *Backing Australia's Ability* policy papers (Prime Minister, 2001, 2004), only to fall again from 2004-05 with fiscal austerity measures. Support increased again in 2008-09 with the election of the Labor Government and the introduction of several new and varied initiatives and continued until 2015-16 when fiscal austerity prevailed again.

The spike in 2021-22 higher education is due to a one-off $1 billion payment to offset the fall in international student income that universities had been able to allocate to research from 2014.Figure 3 also shows an increase in multisector activities in 2021-22 due to a substantial increase in other health R&D.

4.2 Why HERD investment is important

Higher education expenditure on research and development (HERD) contributes a significant and, until recently, a growing proportion of Australia's national R&D effort. However, this has more to do with the declining effort in other sectors.

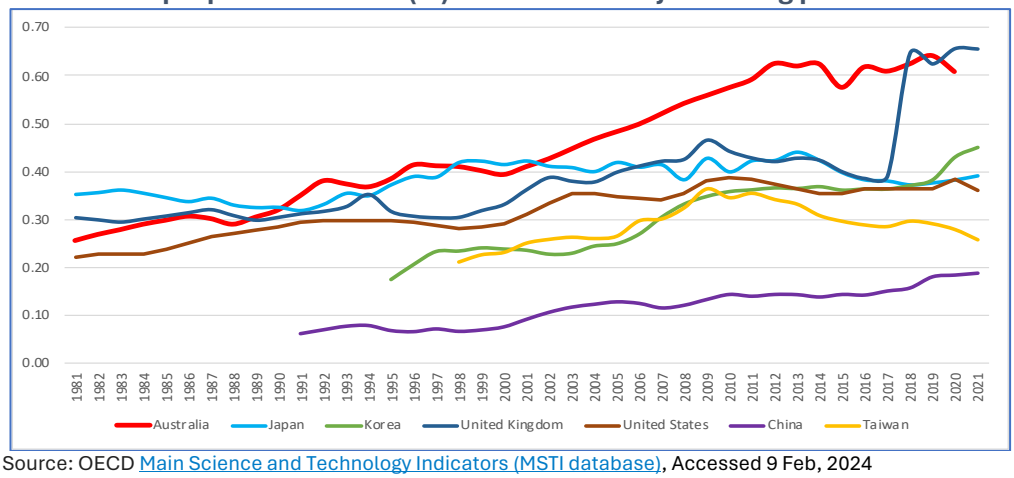
Higher education research is responsible for undertaking fundamental and strategic research that addresses national benefit (and market failure) purposes, provides a framework for preparedness and prescience concerning major threats such as natural disasters and human and animal pandemics, and takes a long-term view on economic, technological, social, and public policy change.

Higher education also trains the future research workforce for industry, government, and higher education itself.

4.3 Contribution of higher education R&D (HERD) to the national R&D effort

Higher education research plays a significant role in the national R&D effort in many countries, particularly Australia, Korea, and the UK. Figure 8 provides the proportion of higher education expenditure on R&D (HERD) in GDP Australia's major trading partners.

Figure 8: Higher Education Expenditure on R&D (HERD) as a proportion of GDP (%): Australia's major trading partners



Source: OECD Main Science and Technology Indicators (MSTI database), Accessed 9 Feb, 2024

The Australian proportion steadily increased from 0.23% in 1981 to 0.61% in 2019 (reaching 0.64% in 2018). The proportion in the UK reached 0.66 in 2019, having shot up rapidly since 2017 due to a change in collection methodology that added R&D funded and performed by HE institutions, as in Australia.

ABS data shows that international postgraduate students undertake a substantial proportion of higher education R&D. The international student fee bonanza is not reflected in the appointment of permanent academic research staff. Causal and short-term project-funded appointments have carried a heavy workload.

The proportion of HERD in Australian GDP increased substantially from 2001 to 2012. This was supported by Australian Government payments to universities for research, totalling $37.6 billion (inflation-adjusted to 2020-21 dollars), including payments under the Education Investment Fund (EIF) program.

Universities have also been able to divert funds from "profits" on teaching to research and allocate income from international students for research purposes. Funds have been applied to both research staff costs and investment in research infrastructure—purpose-designed buildings, facilities, equipment, and instruments. In recent years, universities have been borrowing from the financial markets and entering into public-private partnerships (PPPs) to finance some capital expenditures.

Until now, higher education appears to have been doing the "heavy lifting" in Australia's national R&D effort (Howard, 2020). However, without international student revenues, the capacity for the Australian higher education sector to contribute to Australia's R&D effort will decline. Without direct policy intervention, it is likely to continue in this direction. Reliance on international students to drive the Australian HERD effort and national R&D expenditure reflects lazy R&D policy.

While the value of public investment in higher education research and development has been increasing recently, its proportion in the overall investment "portfolio mix" has fallen. There must be a continuing commitment to higher education research, particularly in fundamental and basic research. While higher education is complementary to research in other sectors, it has characteristics at the foundations of Australia's research effort.

4.4 Sources of funds

In 2018, Australian HERD amounted to $12.2 billion. Traditionally, universities have financed a substantial proportion of HERD from "internal university funds". In 2018, this amounted to 56.1% of HERD ($6.8 billion). Other funding sources include payments by State and local governments, businesses, and donations and bequests. These sources amount to approximately 10% of HERD.

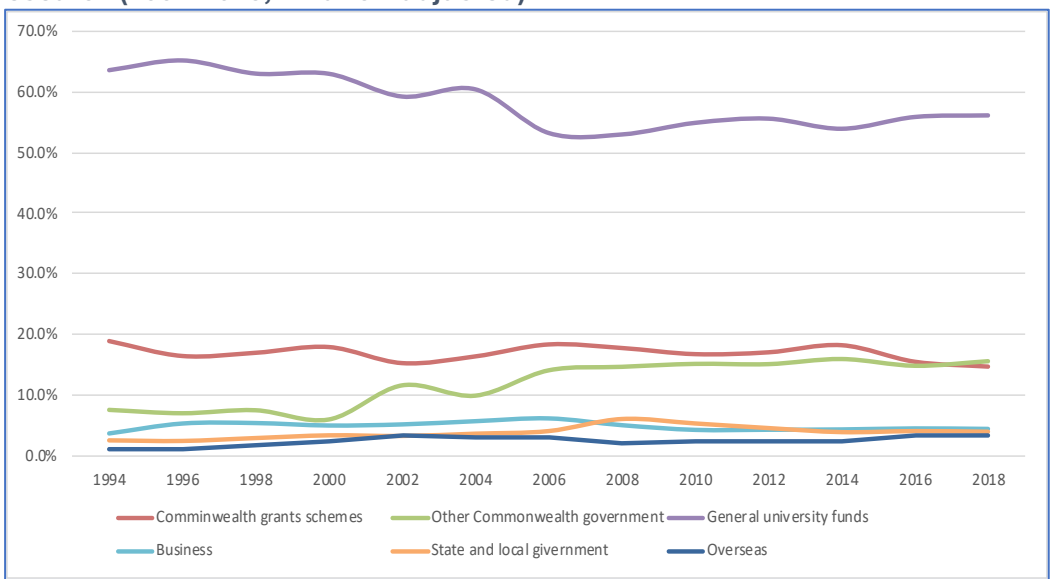
Over many years, a substantial proportion of internal funds has been provided by the "teaching surplus"—the difference between the cost of providing teaching and learning services to students and external funds provided ostensibly for teaching and learning proposals, including Government Financial Assistance Grants and HECS/HELP payments. These external sources have been declining in real terms as student numbers flatlined in 2014 and teaching costs increased.

Since 2014, the primary source of internal funding for HERD has been international student revenue. Without the international student boom that commenced in earnest in 2014, the level of internal financing for research would have probably gone the other way.

In terms of trends, the proportion of funds for HERD derived from internal sources has been declining since 1996, when it peaked at 65%. This is shown in Figure 9. The trend flattened in 2006, rose slightly to 2012 and fell again in 2014. The trend increased to a new level in 2016 with international student income.

Also, since 1994, the proportion of payments under Commonwealth competitive grants schemes to support HERD has fallen from 20% to 15%. The business proportion also fell from 8% in 1996 to 4% in 2008.

Figure 9: Trend in proportions of funding sources for Australian university research (1994-2018, inflation-adjusted)



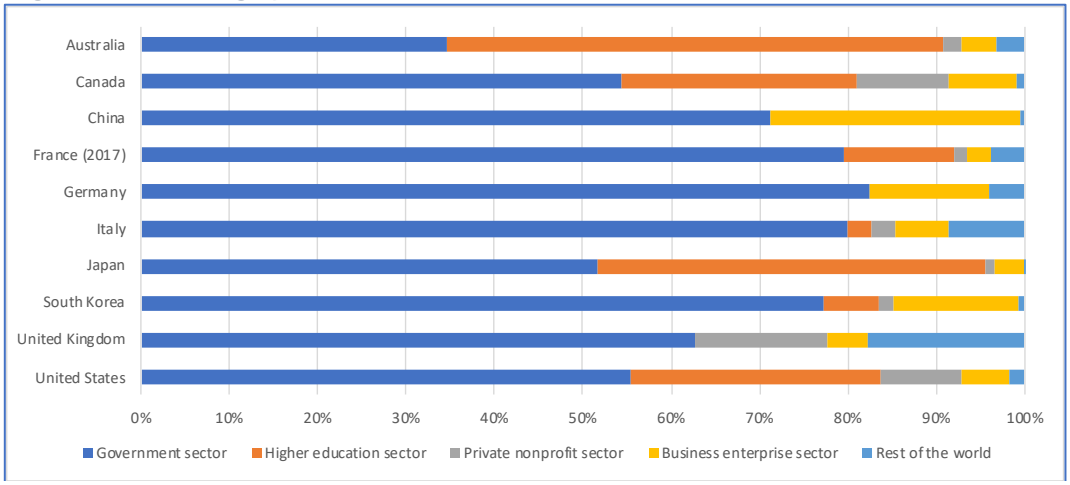
Source: Australian Bureau of Statistics,

From the ABS data, it would appear that the Commonwealth only contributes 30% to HERD expenditures, with internal university funds making up over 50% of funds available. As noted above, these funds have been sourced increasingly from international student revenues, including international postgraduate students. However, following international conventions, the ABS classifies funds received from formula-driven block grants as university funds, whereas the Department of Industry SRI Tables define this assistance as government support.

Other internal funds include research commercialisation income (royalties, licenses, and assignments of IP), collaboration income, commissioned research and consultancy, interest received on investments, donations, and bequests; profits on business enterprise activities; and a range of user charges, fees, and fines. But in the overall scheme of things, the amounts are relatively small, although they have been increasing.

As shown in Figure 10, Australian reliance on university funds is much higher than in comparable R&D-performing countries.

Figure 10: Funding by sector for HERD for selected countries: 2018



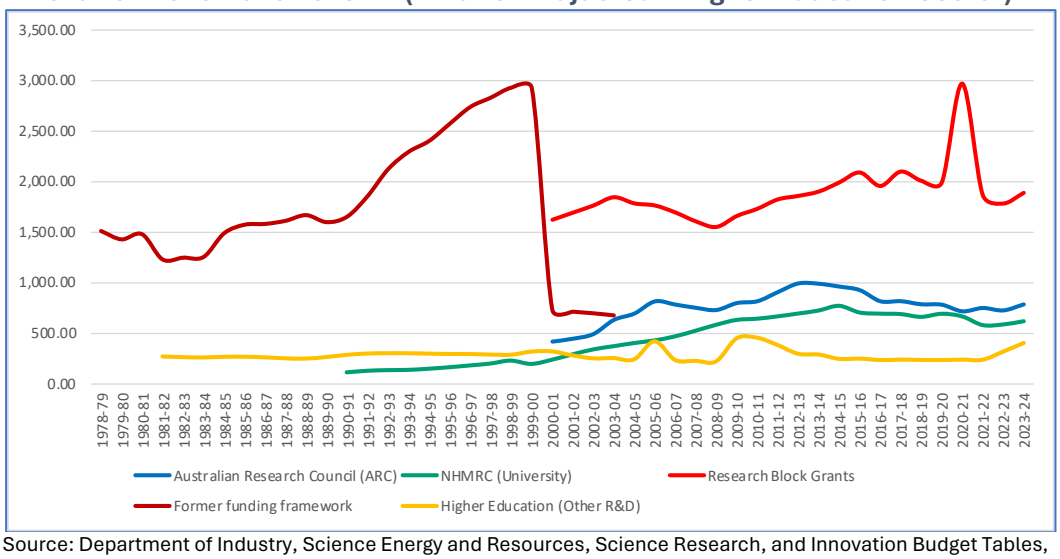
Source: Support for Academic R&D, Academic Research and Development, National Science Foundation Science and Engineering Indicators. Based on OECD data.

With this high level of internal funding, HERD is a large component of the Commonwealth's small commitment to Australian public research investment, which will be $11.9 billion in 2021 (up from $10.2 billion in 2019-20) and makes up only 1.87% of GDP.

4.5 The progressive shift towards Ministerial and departmental funding decision-making

Over the years, the proportion of higher education research investment has shifted away from independent research funding councils, particularly the Australian Research Council (ARC) and the National Health and Medical Research Council (NHMRC), to direct payments from Departments, including the DESE Research Block Grants (allocated on a formula basis). These trends are shown in Figure 11.

Figure 11: Australian Government Public Investment in Science, Research, and Innovation 1978-79 to 2023-24 (Inflation-Adjusted – Higher Education Sector)



Source: Department of Industry, Science Energy and Resources, Science Research, and Innovation Budget Tables, https://www.industry.gov.au/sites/default/files/2021-12/2021-22-sri-budget-tables.xlsx.

By 2023-24, only 38% of public investment in higher education research was allocated through "independent" funding councils: 21.3% by the ARC and 16.7% by the NHMRC. A total of 51.1% was allocated through the formula-driven "block grants" process. Grants are determined based on each university's performance in attracting external research income and supporting students to complete higher education through research.

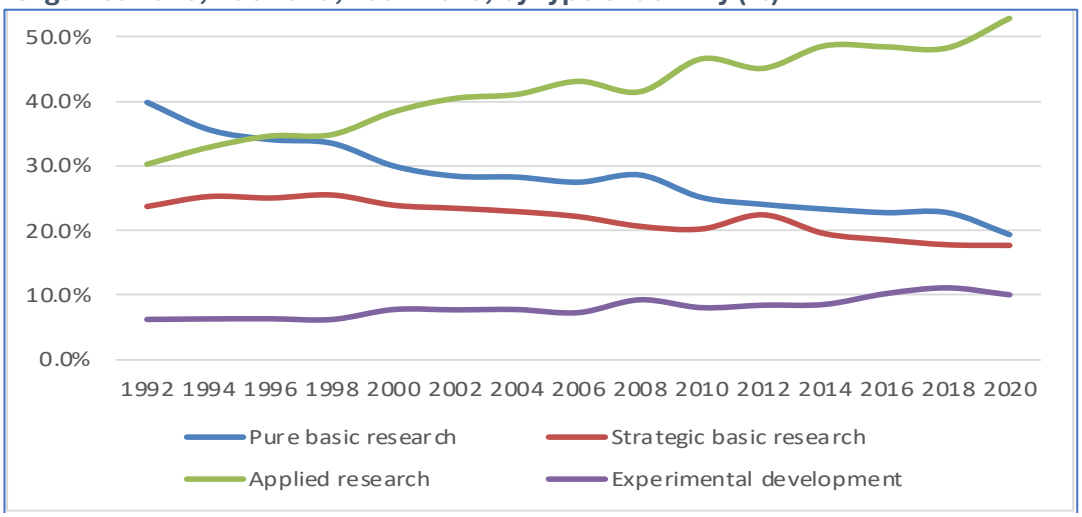
In 2023-24, $2.24 billion in block grants will be provided to 43 eligible Australian universities—$1.20 billion through the Research Training Program and $1.04 billion through the Research Support Program.

Universities can allocate block grant funding to support students (domestic and international), research projects, researchers, equipment, and infrastructure. This can include research and research training partnerships with businesses, international providers, and other organisations.

4.6 The trend towards applied research

There has been a shifting trend towards applied research that began in the late 1980s, as shown in Figure 12 below. The proportion of basic research (pure and strategic) fell by over half—from 63.6% of research activity in 1992 (the earliest year figures are available) to 40.6% in 2018. Applied research and experimental development increased from 36.4% to 59.4%.

Figure 12: Research and Experimental Development, Higher Education Organisations, Australia, 1992-2020, by type of activity (%)

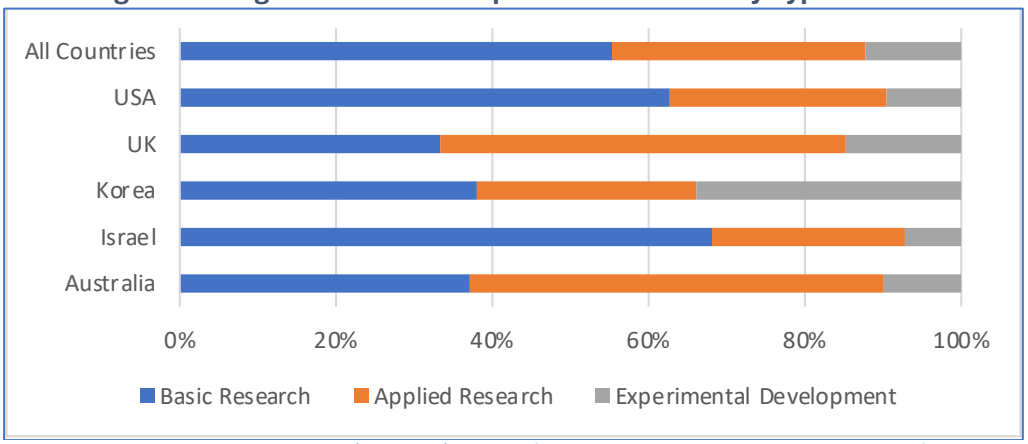


Source: Calculated from ABS, Research and Experimental Development, Higher Education Organisations, Australia, 2020. Bi-annual from 1992

This trend towards applied research and experimental development has been strongly encouraged by government research commercialisation agendas and the inability of research lobbies to maintain a narrative about the importance of basic research. The trend has pushed universities into the areas occupied by publicly funded research agencies (PFRAs), particularly CSIRO and state-based agricultural research institutes.

The distribution of investment among types of R&D in several other countries is shown in Figure 13.

Figure 13: Higher Education Expenditure on R&D by Type of R&D



Source: OECD Dataset: Gross domestic expenditure on R&D by sector of performance and type of R&D

Figure 13 suggests that—

- In Australia, 53.0% of higher education research is applied research, and 9.9% is experimental development.
- Commitment to basic research is strong in Israel (68.2%) and the US (62.7%) but less so in Australia, Korea, and the UK.
- Korea has a proportion of 38% basic, 28% applied and 34% experimental development.[3]

[3] The South Korean conglomerates (chaebols) play a significant role in partnerships with universities and research institutes. These businesses are likely to seek both applied research and experimental development in ongoing research programs.

- The high commitment of higher education to basic research in the US may reflect the very large commitment to applied research in National Institutes and Government Laboratories.

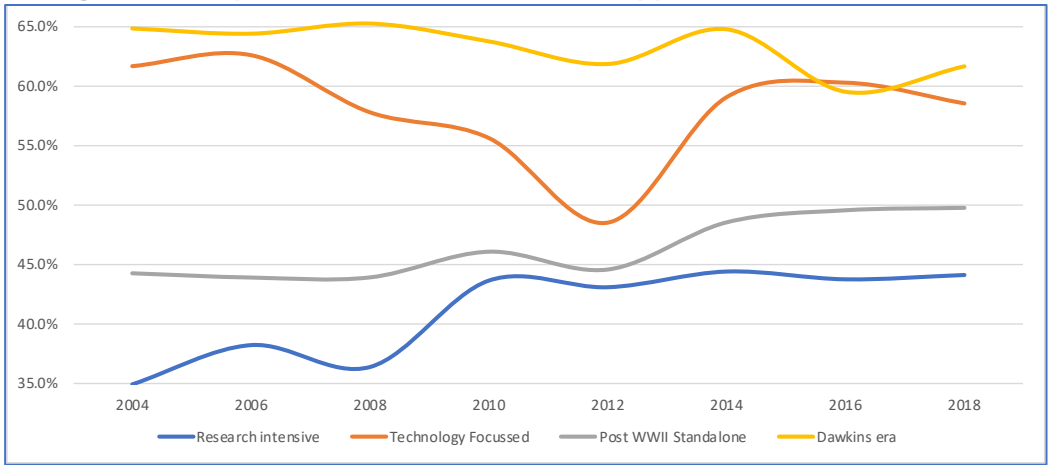
In a portfolio sense, and compared to other countries, the Australian situation would appear to lack balance. While basic research amounts to 37.1% of research, a more appropriate allocation when considering an end game of research commercialisation might be to aim for a smaller commitment to applied research and a greater commitment to experimental development.

A very small commitment to experimental development means that research at the applied stage is generally not ready for widescale adoption, application, and use in government and business. Experimental development requires testing, validation and scale-up before addressing commercialisation opportunities. Universities may be constrained in this area due to gaps in research infrastructure, such as testing instruments and scale-up facilities. It is understood that the NCRIS program is seeking to address these gaps.

A greater commitment by Australia to experimental development would drive the potential for adoption and application, including research commercialisation. This would address a criticism from venture investors over many years that university research is not "investment ready". To do this, higher education would require a better alignment of system settings, support structures and incentives provided to university research leaders to focus on research application.

Figure 13 below shows the increasing proportion of applied HERD among university groups. The shift is particularly apparent in the research-intensive and technology-intensive universities (except 2012). The Post Dawkins universities have been reducing their proportion of applied research.

Figure 14: Proportion of HERD allocated to Applied Research 2004-2018



Source: DESE, Higher education expenditure on R&D (HERD) by university, https://www.dese.gov.au/research-block-grants/resources/higher-education-expenditure-rd-herd-university

The shift towards applied research has also meant letting businesses off the hook regarding their commitment to applied research and experimental development and seeking to rely on university research and its commercialisation. The shift is also symptomatic of the failure of the RDTI to lift business R&D investment.

During the 1990s, as part of the Friedmanite imperative of capturing shareholder value and corporate breakups and rationalisations, corporate R&D commitments were cut severely, particularly in large Australian companies like BHP and Telstra. For example, with the breakup of BHP, R&D capability moved to higher education institutions (Howard Partners, 2013).

5 Other areas of concern

5.1 Fluctuating trends in direct Australian government research investment

Australia has a diverse range of world-recognised government research organisations (GROs). These organisations conduct long-term, mission-led research in critical areas for Australia and the world. They have enduring international relationships and support research globally, including through their role as hosts for large-scale research infrastructure facilities and scientific collections.

The Commonwealth's interest in public research goes back a long way, commencing with the establishment of CSIRO in 1916. CSIRO and the state agricultural research stations were critical for research, development, and innovation in Australian agriculture.

The Commonwealth Serum Laboratories (now CSL Ltd) was established in 1916 to service the health needs of a nation isolated by war.

There had been a progressive expansion of defence research laboratories and defence production facilities starting in 1926 (many privatised during the 1990s). The Defence Science and Technology Organisation (now DST) was established in 1974 by integrating the Australian Defence Scientific Service, the in-house R&D units of the Armed Services, and the Science Branch of the Department of Defence.

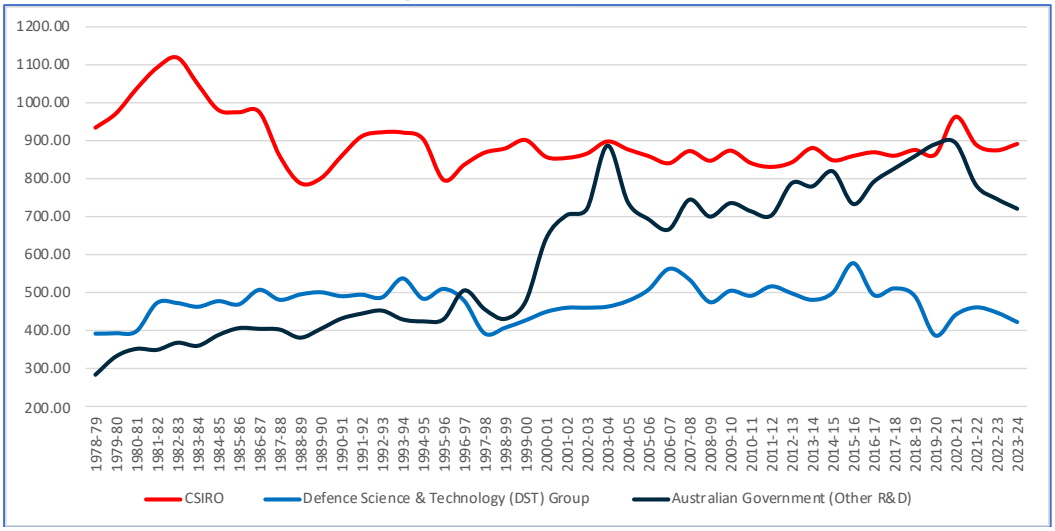
The Bureau of Mineral Resources, Geology and Geophysics (BMR) was established in 1946 to undertake systematic geological and geophysical mapping of the continent as the basis for informed mineral exploration. It is now known as Geoscience Australia.

The Australian Atomic Energy Commission (now ANSTO) was established in 1953

State governments also have a long-standing interest in agricultural, mining, and medical research, but their commitment has been declining due to fiscal austerity and some cost-shifting as the Australian Government increased its funding for health, education, and rural research.

Figure 14 shows the pattern of Commonwealth SRI investment on its own behalf. It illustrates a falling commitment to CSIRO, offset to some extent by other government-supported research. The commitment to defence research has waxed and waned, with the commitment in 2020-21, not much more than in 1979.

Figure 15: Australian Government Public Investment in Science, Research, and Innovation 1978-79 to 2023-24 (Inflation-Adjusted – Government Sector



Source: Department of Industry, Science Energy and Resources, Science Research, and Innovation Budget Tables, https://www.industry.gov.au/sites/default/files/2021-12/2021-22-sri-budget-tables.xlsx

The defunding of CSIRO since 1984-85 occurred when the Government's commitment to higher education research through the ARGC was increasing. This may have reduced CSIRO's available funding for discovery and strategic basic research. In 1988, under Ministerial Guidelines, CSIRO was mandated to generate 30% of its funding from external sources. This was achieved in 1991 and maintained since then.

External funding pushed CSIRO into applied research and experimental development. However, it left a gap in strategic basic research as universities were also being pushed into applied research, as shown in the trends in Figure 12 above.

A substantial proportion of these external funds were sourced from producer levies collected by the Rural Research and Development Corporations. This helped CSIRO continue its preeminent role in agricultural, food and fibre research and generate a continuous pipeline of animal and plant production innovations. Only since 2020-21 has CSIRO been successful in increasing its government funding.

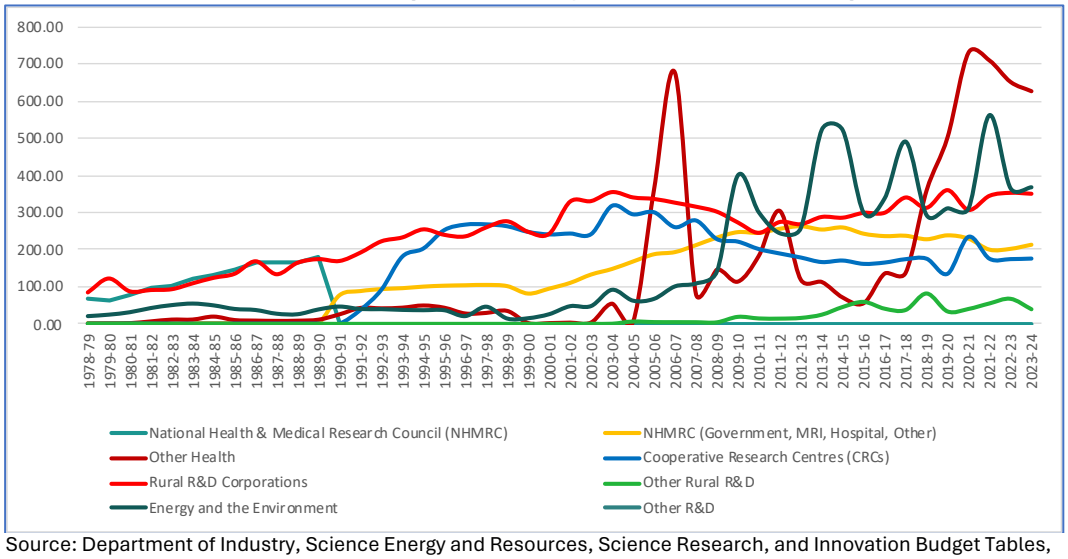
The other government research investments cover the following:

- The Australian Nuclear Science and Technology Organisation (ANSTO)
- Australian Institute of Marine Science (AIMS)
- Geoscience Australia
- Bureau of Meteorology
- Australian Antarctic Division
- Australian Astronomical Observatory (Australis)

5.2 The haphazard nature of "Multisector" research investment

The trends in multi-sector SRI investment reflect what would appear to be an uncoordinated and haphazard multiple agencies/program commitment, particularly since 2005-06, as illustrated in Figure 16. Behind the oscillations, particularly in Energy and the Environment, Figure 16 shows the increasing commitment to medical research, the relatively stable commitment to rural R&D corporations and the producer levy system, and the declining commitment to the CRC program since 2003-04. However, there was a lift in funding in 2020-21.

Figure 16: Australian Government Public Investment in Science, Research, and Innovation 1978-79 to 2023-24 (Inflation-Adjusted – Multi-Sector)



Source: Department of Industry, Science Energy and Resources, Science Research, and Innovation Budget Tables, https://www.industry.gov.au/sites/default/files/2021-12/2021-22-sri-budget-tables.xlsx

The Australian Government has supported medical research over a very long period—since the formation of the National Health and Medical Research Council in 1926. This growth has occurred through medical research institutes and departmentally administered research funding programs.

The Australian Association of Medical Research Institutes (AAMRI) has 58 member organisations, internationally recognised as leaders in health and medical research across a broad spectrum of human health issues. These include preventive health, chronic disease, mental health, immunology and Indigenous health.

5.3 The limited scope of university-government research partnerships

Universities, government organisations and other research organisations come together occasionally to create formal research partnerships. But arguably, there is not enough of this.

There are numerous examples of government-university research partnerships, although not so much with industry. They include:

- The Australian Atomic Energy Commission (AAEC), founded in 1953 for industrial and defence purposes, brought together activities related to uranium mining in Rum Jungle in the Northern Territory and Marcus Oliphant's work at the ANU.

  The AAEC established the nuclear research facility at Lucas Heights in 1958. It involved collaborations with the other universities to establish the Australian Institute of Nuclear Science and Engineering (AINSE) in 1958. It was a precursor to ANSTO, which was established in 1987

- The Mt Stromlo Observatory, established in 1924 as The Commonwealth Solar Observatory, has close links with the ANU through joint staff appointments and graduate studies.

  A formal amalgamation took place in 1957, with Mount Stromlo Observatory becoming part of the Department of Astronomy in the Research School of Physical Sciences at ANU, leading eventually to the formation of the Research School of Astronomy and Astrophysics in 1986.

Universities have adopted a pragmatic approach to these developments, taking opportunities where they arose while seeking to influence the Commonwealth's priorities where advantageous. Their approach was opportunistic rather than strategic.

The Australian Synchrotron provides a significant success story in partnerships between universities, public research organisations, and Commonwealth and State Governments. The Victorian government took the initiative to build the Synchrotron in 2001 as part of its STI initiative. Commonwealth Public Research organisations were initially involved, and a direct Commonwealth Government came much later, in 2015.

The making of the Australian Synchrotron

As synchrotron science revolutionised experimental techniques in the UK, Europe and the USA in the late 1970s, Australia's science leaders saw the potential for a national light source to spur scientific investigation and industrial innovation in this country. In 1989 the Australian Academy of Science first proposed that a national synchrotron facility be made available for Australia.

For 16 years Australian scientists used overseas synchrotrons for groundbreaking research, but demand for beamtime far outstripped supply and it was clear that for Australia to remain internationally competitive, Australian researchers needed much easier access to a light source closer to home.

In 1993 the Australian Science and Technology Council (ASTEC) recommended Australia build its own synchrotron. Two years later, funding was granted for a feasibility study into an Australian Synchrotron and the study was completed in 1997.

In 1999 a detailed proposal was submitted to the Federal Government, and this became the basis for the Australian Synchrotron.

In June 2001 the Victorian Government announced its decision to build a national synchrotron facility on land adjacent to Monash University. The Victorian Government committed to funding the synchrotron machine and building to house the facility. Beamline capital funding came from partners such as research institutions and

state governments. State agencies were given carriage of the task of building a national partnership and constructing the most significant addition to Australia's research and development infrastructure in decades.

In 2002 the National Science Advisory Committee (NSAC), comprising experienced synchrotron users in Australia and New Zealand and two international advisory committees – the International Science Advisory Committee (ISAC) and the International Machine Advisory Committee (IMAC) – were established to help guide design and development of Australia's first synchrotron light source.

After extensive site preparation, construction of the Australian Synchrotron began in 2003. The project was scheduled to take five years to complete.

In January 2004 the then Minister for Innovation and Acting Premier, The Honourable John Brumby, announced the University of Melbourne, Monash University, Australian Nuclear Science and Technology Organisation (ANSTO) and CSIRO would each provide $5 million towards nine initial beamlines planned for the Australian Synchrotron project. These nine beamlines had been chosen through a rigorous consultation process and were planned to cater for current and emerging demand for synchrotron techniques Australia-wide. Later in 2004 New Zealand announced it would join the beamline funding partnership.

In 2005 the Association of Australian Medical Research Institutes (AAMRI) joined the beamline funding partnership, and Queensland became the first Australian state to join the beamline partnership, in what was now emerging as a new collaborative capital funding model for major national science facilities.

The first beamline contract was awarded in October 2005 to supply a high-throughput protein crystallography beamline that would help develop new treatments for diseases such as Alzheimer's, arthritis and malaria.

In June 2006 the Australian Synchrotron project reached a major milestone with engineers and scientists achieving 'first light', confirming that the machine was working as planned.

Contracts to supply soft x-ray and infrared beamlines for the Australian Synchrotron were signed, and by the end of 2006 funding commitments for the initial nine beamlines had reached $50 million after consortia from New South Wales, Western Australian and South Australian/La Trobe University joined the partnership. The Commonwealth Government also came on board with a $14 million contribution from National Collaborative Research Infrastructure Strategy funds, underlining a major shift towards greater collaboration to meet national research requirements.

Australian Synchrotron operations commenced in July 2007 with five beamlines in operation; two with a full user programme and three with expert users. A further four beamlines were under construction to be commissioned progressively in 2008.

By the end of 2007 the Commonwealth and Victorian Governments finalised an agreement under which each would provide $50 million in operating funds, to a total of $100 million for the period to 2011-12. The New Zealand Government has also committed to contribute operating funds.

On 31 July 2007, the Premier of Victoria, and the then Federal Minister for Education, Science and Training, officially opened the Australian Synchrotron. Mr Brumby emphasised that although the Victorian Government had provided $157 million of the $221 million in capital dedicated to building it, the Australian Synchrotron was not just for Victoria but for all Australians and open to international synchrotron scientists.

http://archive.synchrotron.org.au/about-us/history

The Australian Synchrotron supports the research needs of Australia's major universities, research centres, and businesses, from small-to-medium enterprises to multinational companies.

In 2015, the Australian Government announced a ten-year, A$520 million investment in the Synchrotron operations through ANSTO. In 2020, it was used to help map the molecular structure of the COVID-19 virus during the ongoing COVID-19 pandemic.

The recently announced $940m PsiQantum investment offers a similar opportunity to access a completely new class of technology. PsiQuantum board member Peter Barrett justified the investment by likening the advent of quantum computing to reaching the moon[4].

[4] Yim. Noah 2024. 'They are building small machines: PsiQuantum board member downplays local quantum computing concerns", *The Australian Business Review*, 20 May 2024

6 The parlous state of public science and research investment policy

6.1 Silos and turf wars

Australian science and research policy development has fallen between multiple ministerial and bureaucratic silos – education and science/industry. The relationship between the two has been fraught with differing objectives and conflicting strategies for many years.

The inconsistencies have been allowed to fester, resulting in universities being left to their own devices to fund their commitment to the national research effort. This is not to conclude that universities are entirely blameless in reaching this situation. They have pursued a narrative that, while having strong internal meaning, does not engage with the stakeholders and constituencies essential to supporting their future. They continue to operate in an echo chamber.

They are caught between their missions to undertake basic research to generate new knowledge and government and industry demands and edicts to prepare people for jobs. They have increased their focus on industry-relevant applied research, which they were not initially set up to do. Some are tending towards a role of Research and Technology Organisations (RTOs), which many would see as a welcome development[5].

This focus on applied research fills a gap caused by Governments, the Commonwealth and States neglecting to resource their own public research agencies. The CSIRO has been starved of funds for years, and the Government is just starting to redress the situation – stirred into action by an effective CEO. State Government agricultural research has been progressively defunded through continuous fiscal austerity.

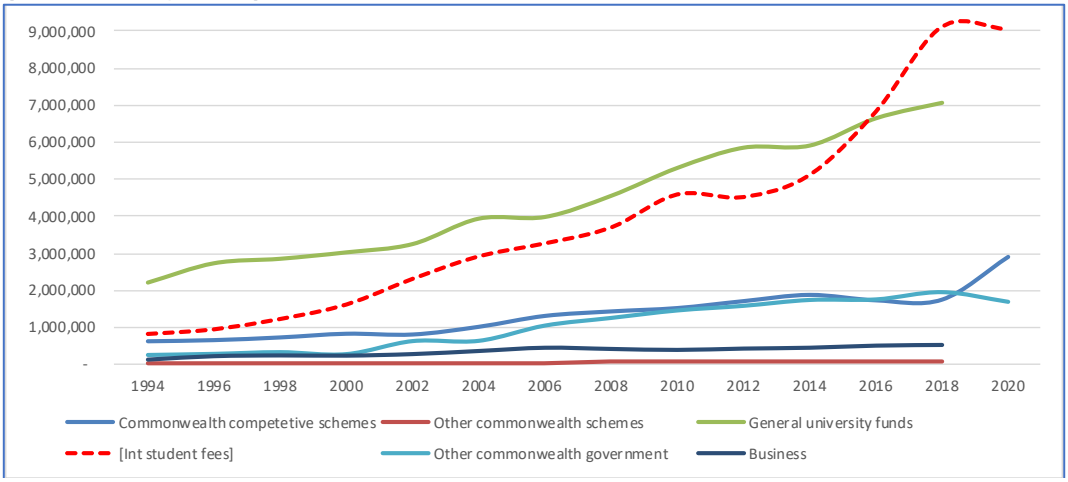
6.2 Reliance on international student income to fund university research

Universities have exploited the global student market to support their own research endeavours – a strategy that has not been without considerable risks to the sector's long-term sustainability. However, from a national R&D perspective, it is not sustainable.

In 1994, Australian universities financed only 27.8% of their internal research funding from international students. By 2016 international students contributed the equivalent of *all internal university* funds for research. Not all international student income has been applied to research: universities have used substantial funds for campus development, higher senior executive remuneration, and a range of administrative support and corporate functions.

[5] RTOs are specialised knowledge organisations dedicated to the development and transfer of science and technology to the benefit of the economy and society. They include hubs, laboratories, testbeds, factories and offices for cutting-edge R&D.See European Association of Research and Technology Organisations

Figure 17: Sources of funds for university research investment 1994-2018 (inflation-adjusted)



Source DESE Higher Education Expenditure on R&D (HERD) time series. Estimates for 2020 derived from DESE HE financial statements

This university internal research funding process, with its reliance on a teaching surplus generated from financial assistance grants and increasingly from international student fees, can only be seen as a highly inefficient way of financing this very significant contribution to Australia's national research effort.

Recent initiatives emanating from the *Job Ready Graduates Package* (Australia. Department of Education Skills and Employment, 2020), which endeavoured to align costs of teaching with revenues from Commonwealth Grants and HELP, together with the short-term collapse in COVID-induced international student income, can only exacerbate this problem by establishing the purpose of financial assistance grants being predominantly for teaching and learning activities.

In 2020, the Commonwealth sought to offset the reduction in international student fee income with a $1 billion one-off grant for research in the 2020-21 Budget.

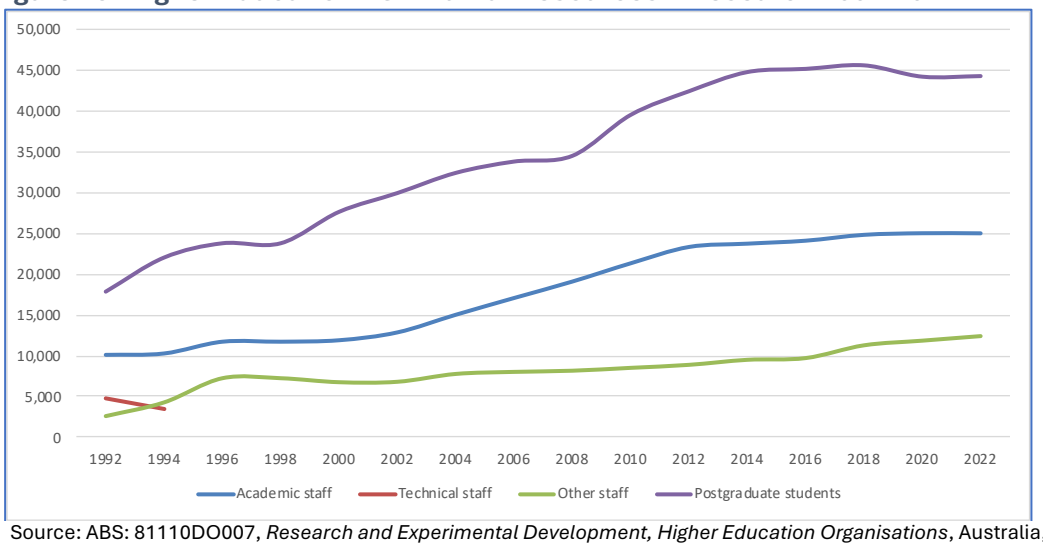
6.3 Reliance on postgraduate students to underwrite the national research effort.

- ***The contribution of postgraduate students***

Regarding the composition of Australian HERD, staff costs make up about 45% and other current costs another 45%. Expenditure on land, buildings, and other capital equipment and scholarships make up the rest.

In 2022, *54.3%* of research staff were postgraduate students. Academic staff made up 30.6%, and other staff 15.2%. The number of PhD students increased rapidly from 2010, while the number of academic staff flattened out in 2012. There is also a growing gap between the number of academic staff and the number of postgraduate students. Trends from 1992 are shown in Figure 18.

Figure 18: Higher Education R&D human resources in research 2004-2022



Source: ABS: 81110DO007, *Research and Experimental Development, Higher Education Organisations*, Australia, various years.

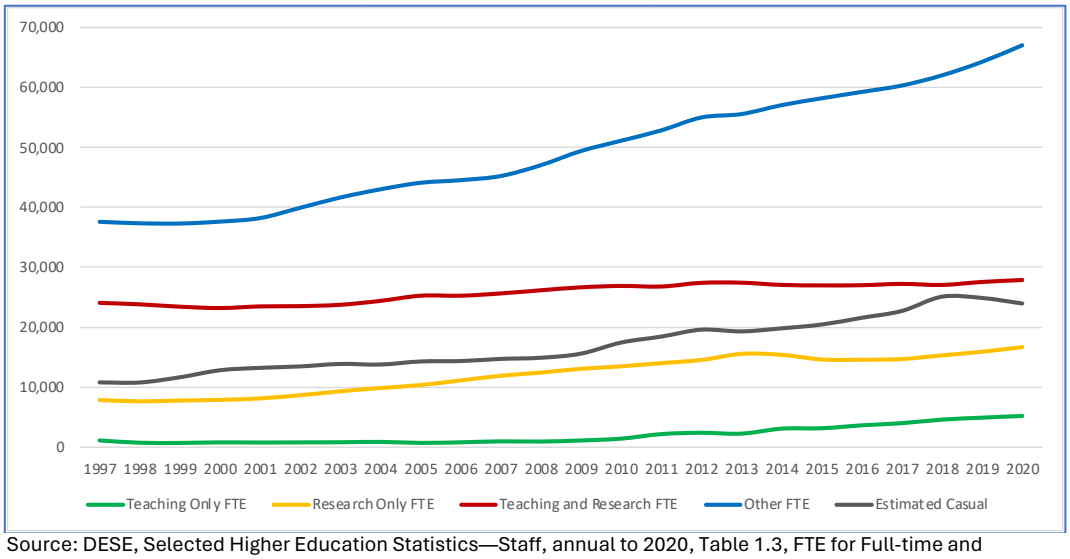
The implications of these trends are not clear. For example:

- The boom in revenue from overseas students does not show up in a trend increase in academic staff since 2012. University financial data suggests that the increase in international student income may have been applied more to new or replacement capital purchases—research facilities, equipment and instruments—than academic salaries.
- It could be that universities have turned away from appointing academic staff and placing greater reliance on postgraduate students to undertake the research effort.
- There is a risk that, to the extent that postgraduate students are attracted to established research programs, they will tend towards "science as usual" or incremental science rather than undertaking high-risk "breakthrough" research.
- The short time frame for the currency of PhD scholarships (3 years) may reinforce this trend.

Figure 19 indicates that since 2014, there has been virtually no growth in the tenured academic research workforce assigned to teaching and research roles. There has been growth in research-only staff, but not so much since 2011. Most of the staff growth has been in teaching-only, non-academic, and casual employment.

Casual staff includes PhD (and other research) students with sessional teaching roles in addition to their research roles and postdoctoral students on an ill-defined tenure track. The data would suggest a switch in university and faculty/research institute preferences for casual research staff and away from tenured staff appointments.

Figure 19: FTE for University Full-time and Fractional Full-time Staff by Function, and FTE Casual Staff, 2011 to 2020



Source: DESE, Selected Higher Education Statistics—Staff, annual to 2020, Table 1.3, FTE for Full-time and Fractional Full-time Staff by Function and Table 1.1 FTE for Full-time, Fractional Full-time and Estimated Casual Staff by Work Contract.

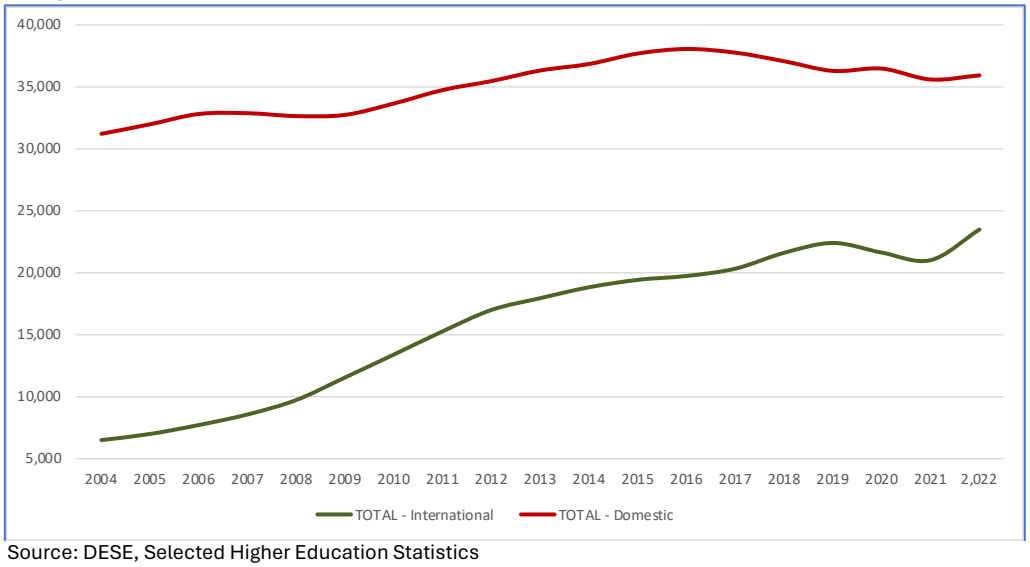
This switch between academic research only and casual research staff would be consistent with the short time horizons relating to the formation of research centres and institutes, including ARC-supported centres, with funding rarely extending beyond three years.

- ***Declining numbers of Australian postgraduate students***

Department of Education data shows that between 2004 and 2022, PhD students in Australian higher education institutions increased by 55.8%—from 37,685 to 66,689.

Overall, in 2022, 31.5% of PhD students were international, compared to 17.1% in 2004. From a knowledge economy perspective, Australian domestic student participation in PhD programs is underwhelming, although there was some increase in 2022. Trends are shown in Figure 20.

Figure 20: Trends in numbers of domestic and international PhD students



Source: DESE, Selected Higher Education Statistics

HERD relies on a growing number of overseas PhD students, meaning that a significant proportion of the Australian R&D effort is generated by international sources. It may be OK if international PhD students come and stay in Australia after graduation to work in businesses or create start-ups, but there are risks that they won't.

On the face of it, to lift the Australian R&D effort, a concerted effort must be made to raise the number of domestic PhD students. Strategies would generally include increased financial support for living costs, more industrial PhDs generated through an industrial strategy for future industries, greater investment in research infrastructure, and greater R&D support for PFRAs to fund PhD candidates.

- ***Differences between domestic and international postgraduate research fields***

Interestingly, and perhaps even more significantly, Table 2 shows a difference between the fields of education chosen by domestic and international PhD students.

Table 2: Proportions of Domestic and International PhD students across fields of education, 2022

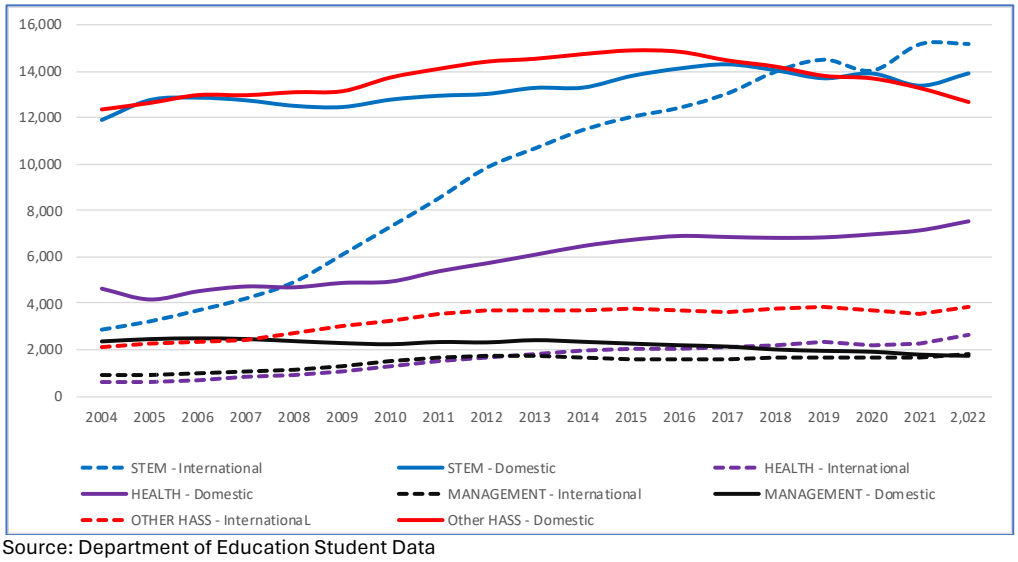
Field of Education	Domestic students (%)	International students (%)	All students (%)
Natural and Physical Sciences	21.6	24.4	22.7
Information Technology	3.2	8.3	5.2
Engineering and Related Technologies	9.0	26.1	15.7
Architecture and Building	1.4	1.8	1.6
Agriculture, Environmental and Related Studies	2.8	4.0	3.3
Health	21.0	11.2	17.2
Education	6.6	7.7	5.3
Management and Commerce	4.8	3.3	6.0
Society and Culture	24.6	11.3	19.4
Creative Arts	4.9	1.8	3.7
TOTAL	**100.0**	**100.0**	**100.0**

Table 2 indicates clearly that international students prefer STEM-related disciplines: 24.4% of international students undertake their PhD research in the Natural and physical sciences (compared to 21.6% for domestic students); 26.1% in Engineering and related technologies (9.0% for domestic); and 8.3% in Information technology (3.2% for domestic).

By contrast, 21.0% of domestic students prefer Health (compared to 11.2% for international students); 24.6% prefer Society and culture (11.3% international), and 4.9% prefer Creative arts (1.8% international).

Figure 21 shows longer-term trends in PhDs by Field of Education. Domestic interest in STEM Fields recovered in 2022, and interest in Health continues to rise. Interest in HASS Fields has waned since 2016.

Figure 21: Numbers of domestic and international PhD students across fields of research



Source: Department of Education Student Data

The public research system should continue to support more PhDs in STEM areas to boost Australia's research and innovation capability in critically important technology-intensive

industries. Under current arrangements, Australia would appear to be assisting other countries in improving innovation performance in these areas.

Strangely enough, technology intensity is infiltrating most industries—for example, Health care equipment and services, Commercial and professional services, Media, entertainment and the creative industries, and Travel and tourism.

The initiative in the *Research Commercialisation Action Plan* to support more industry-oriented PhDs has been very welcome.

At the same time, little is known about Australian students pursuing their PhDs in overseas universities, particularly in the US and Europe.

6.4 Declining numbers of students commencing higher education wishing to undertake research

A US survey, the *Top Reasons US Consumers Choose Their Education Pathways* (Strada-Gallup Education Consumer Survey, 2018), identified several reasons why people enter higher education. They include—

- To build a career or improve career prospects (58%). This covers "To get a job, any job, or a skill that would qualify for a job."
- To acquire and create knowledge (23%)
- To get an education (12%)
- Lifestyle and connections (7%)

Other surveys suggest similar results: *Why do students go to university, and how do they choose which one? Why do different people prefer different university degrees? Motivation choice of degree* (Skarova & Furgusen, 2014).

Comparative Australian data is unavailable, but Australian universities have positioned themselves to meet all student demands/needs/wants. Still, their primary focus and community expectation seems to be on building careers and improving job prospects.

If Australian data were to be similar to the US, with less than a quarter of students wanting to go to university "to acquire and create knowledge," there is a significant constraint on the capacity of Australia's universities to deliver the knowledge and R&D capability essential for Australia's transition to new sources of growth and breaking the productivity problem.

6.5 Policy failures

- ***Failure to support research universities and government research through national research councils***

The NHMRC commenced in 1923 with a charter to support health and medical research in higher education and public research agencies (MRIs particularly).

The NHMRC should have been a model to support research in science and technology after the war, bringing together the work of universities and government agencies, particularly the CSIRO and perhaps the defence establishments.

A similar comment could be made about the Australian Research Grants Committee, which transformed into the Australian Research Council.

Instead, a disjointed funding regime has provided short-term funding commitments to an increasing array of research organisations in the university and broader public research domain.

In practice, funding is influenced less by strategy and more by the demands of public expenditure management and control by a government with deep-seated budgetary problems

caused by soft fiscal policies—a desire to hand out tax cuts rather than build a sustainable public research infrastructure.

- ***Failure to build effective research partnerships between universities and Government Research Organisations – including CSIRO***

This was the initial objective of the CRC program, but CSIRO saw it as a way to make money by charging over-the-top administration fees.

CSIRO was damaged by the Government imposing a cost recovery regime and poor leadership over many years, particularly in the 1990s, when there was consideration within the government for the organisation to be broken up.

As time passes, the differing cultures between universities and public research organisations will need to be reconciled.

6.6 A dysfunctional research investment system that must be unwound and rebuilt

Short-term budgetary decisions have primarily driven the development of the public R&D system in a continuing environment of fiscal austerity. Cuts to universities and research organisations are easy – and effectively "non-decisions" – simply not making new budget provisions and allocations.

Could it be that running a research system on a centralised national basis is just too hard? In other Federal jurisdictions, States, Provinces, and Lander have a much higher profile in delivering higher education and public research.

The current national approach that tries to deliver public research investment and outcomes across 42 autonomous universities, Commonwealth and state public research agencies, and 58 MRIs may not be delivering an effective and diverse national research strategy that considers State, Territory, and regional differences and preferences and, at the same time, focuses on national capabilities in an increasingly globally connected world.

Over the last 25 years, most States have developed their own separate research investment strategies that reflect their understanding of their regional competitive advantages. There appears to be little relationship between these strategies and the implied national public research strategy. At the same time, the location of important national research facilities and capabilities is quite often determined by political considerations, electoral pressures, and financial bargains.

This needs to change. For a start, the decision frameworks for investing in public research should be entirely separate from resourcing decisions about universities and other higher education institutions' teaching and learning responsibilities.

Underpinning these contradictions, there has also been a fundamental failure to understand why our nation invests in public research. Augments are couched in economic terms, such as market failure, and essentially overlook the government's responsibilities for achieving socio-cultural outcomes and for prescience and preparedness. This observation had application during the COVID-19 pandemic.

Much could have been learned from Australian Agriculture's preparedness for major pandemics such as FMD. These responses have been characterised by close collaboration between the Commonwealth and States through well-established and functioning Ministerial Councils.

6.7 The result: no shared vision, no consistent strategy

Many books have been published on the evolution of the Australian higher education system. These tend to be essentially unquestioning policy narratives (Croucher et al., 2013; Croucher &

Waghorne, 2020; Davis, 2013, 2015, 2017; Macintyre et al., 2017). This body of work explains the history and provides a source for assessing what went wrong.

Claimed connections within national innovation or regional innovation systems are not easily validated empirically. They tend to reflect an assessment of potential rather than assessing economic impact and performance. They reflect ex-post rationalisations rather than the outcome of planned and deliberative strategy.

Many initiatives in innovation ecosystems are essentially property developments. This has begun to change as policymakers see tangible benefits from support for innovation districts, precincts, and hubs.

Nonetheless, we are now reflecting on the impact of "policy on the run". This has resulted in significant policy blunders based on short-term cost considerations and armchair rationalisations of the advantages of scale and consolidation, which pushed the system in a sub-optimal direction. These rationalisations focused little on a vision or strategies to achieve that vision.

7 Where to from here?

7.1 A shared responsibility

Government (Commonwealth and State), higher education, business, and publicly funded research agencies are responsible for improving Australia's public R&D performance.

7.2 Building on strengths

We should not rely on or expect higher education institutions to do the heavy lifting in building Australia's R&D capability. They are an essential part of the equation but not the entire solution. They work to their own statutorily assigned missions and look to a range of revenue streams, including educating international students, to support those missions.

- ***The Cooperative Research Centres Program***

The Cooperative Research Centres (CRCs) program, which commenced in 1991, was devised to build and strengthen connections between universities, business, and government. It has been an effective instrument, developing a global reputation and being replicated in many countries.

Public policy should not always seek new models but build on the strengths of what is already in place. Of course, there is always room for improvement in the light of changing situations and circumstances, but these should not be unwound to provide space for untested ideas, theories, or fads.

The CRC-P initiative is an excellent example of building on what is already there.

- ***Established research infrastructure***

The Australian *and* State governments have the elements of a robust research infrastructure to support industry development with government-owned and funded research organisations, although support has slipped recently. State-owned agricultural research institutes continue to support rural innovation in some States.

CSIRO is recovering from policy experiments with mandated external funding requirements and continued requests for efficiency dividends in fiscal austerity regimes. In the May 2021 Budget, CSIRO received $459m to address any reduction to its external revenue resulting from the impact of COVID-19 and to focus on biosecurity, rural innovation, and the implications of climate change.

While it is easy to assert that more government money will enhance collaboration, effective collaboration will require research infrastructure and institutional frameworks that involve

higher education, business, and government working together in new ways to build and deliver research and innovation outcomes.

Existing public research organisations, which have established relationships with higher education, business, and government, provide essential building blocks. Still, the scope and scale should be extended to provide broader industrial coverage and offer more places to Australian students wishing to undertake PhDs and post-doctoral fellowships with a solid industrial orientation.

- ***Research partnerships***

In recent years, interactions and engagement between public research organisations and businesses have strengthened, but there is still some way to go towards achieving the much sought-after "triple helix" partnership of university-business-government relationships at scale.

Effective partnerships arise from a longer-term commitment built around the development of 'social' and 'relational' capital at the executive level in each sector: each must genuinely understand how the other works and the nature of the institutional drivers.

It is possible to point to some collaborative successes in research, education, professional development (training), and extension (outreach), but overall achievement is patchy. It is impossible to pinpoint a formula for success outside the social and relational dimensions.

These factors indicate a requirement for capacity and capability to create longer-term trust-based relationships between university staff and senior managers in business and government. This is the cornerstone of effective engagement management. Inevitably, people do business with people they trust.

Universities have been using a variety of engagement instruments, including adjunct and visiting appointment policies, to build business and government relationships. University executives and senior staff also participate actively in business forums, corporate advisory councils, and regional development councils.

The Australian Business-Higher-education Round Table (BHERT) was founded in 1990 to foster industry-university connections in research and community service. Its work was exemplified in its annual collaboration awards. BHERT was closed in 2019.

Of course, effective engagement is much less about structures and more about people wanting to ensure that effective relationships and interactions are developed, managed, and sustained. However, in a tight economic climate, this activity must be funded, and value must be seen to be created and delivered for all parties.

7.3 Building a research workforce

Young aspiring academics struggle to make a career out of research. Moreover, the pathway to eminence depends on a capacity to generate research income through government competitive grant schemes and from industry, to build research teams, and to develop strong trust-based relationships within a research organisation and externally with government and industry.

In the academic world, we can think of a research talent pathway that starts with nurturing interest among the broader community and works its way through primary and secondary education, tertiary education (higher education and VET), research training via a PhD, a postdoctoral appointment, an early career research position, then climbing the academic ladder to become an eminent scientist working on "new to the world" innovations.

This is by no means an easy task, and while government and institutional support exist on some sections of the pathway, they are absent in many others.

Currently, capable research students in many STEM areas receive multiple job offers after and even before completing their undergraduate studies. For many, it is too much to consider forgoing income for at least another three years to complete a PhD.

Moreover, businesses seeking talent are offering more final-year undergraduate scholarships and internships. In Agriculture, for example, there are said to be four jobs available for each graduating student.

The capacity to capture opportunities in strategically important industries will be heavily contingent on having a sustainable, domestically oriented R&D workforce with the necessary talent to undertake and deliver world-class research in Australia that will lead to "new to the world" innovation and commercialisation.

The public research system must be much more competitive in building its talent base.

7.4 Governance and organisation framework

The R&D system is governed by a shaky scaffold of ministerial portfolios, departments and agencies, programs, and activities. The governance setting is also "noisy," with a multitude of advocacy and representative groups seeking to convey their views and interests to decision-makers through an increasing variety of channels.

Entities are created, redesigned, or abolished almost continuously. Rather than extending programs and arrangements to accommodate new policy initiatives, Ministers and their advisers often like to ensure longevity with new legislation and regulations[6]. The situation is replicated at the State/Territory Government levels, alongside numerous Commonwealth-State consultation and collaboration arrangements.

The reality is that the conduct of modern-day public administration and public policy is inherently complex and sometimes seen as "overloaded"[7]. The task of coordination is immense—and imperfect. There are often attempts to reduce this overload, but with limited impact. It continues to expand.

Commentators focus on how this government machinery could be coordinated and restructured to deliver consistent and coherent policy outcomes. However, this focus on structure shifts attention away from developing a national strategy and how it would be delivered in this highly complex organisational arrangement.

Policy analysts and management advisers know that a good policy or strategy can be developed and delivered through almost any structure, *provided that* implementation directions are clear, resources (skills, knowledge, funds, technology) are available, and responsibility and accountability frameworks are in place.

7.5 Recognising constraints

The constraints on building on strengths and achieving a national approach to public research are well-known and have been canvassed elsewhere (Green & Howard, 2015a; Howard, 2012, 2018, 2020). They include:

- Ambivalent long-term commitment from the Commonwealth Government and the Opposition parties
- The system of public expenditure management and control that focuses on "reigning in" deficits and avoidance of long-term funding commitments

[6] The previous Government's *Higher Education Research Commercialisation Action Plan* was legislated by an amendment to the Higher Education Support Act – *the Higher Education Support Amendment (Australia's Economic Accelerator) Act* 2022.
[7] See, for example, Howard, John H (1984). Extended Essay: Perspectives on Overloaded Government, *Australian Journal of Public Administration*, XLIII (4), December 1984, pp332-403.

- Failure to commit for an extended period; long-term commitments disappear under the clouds of fiscal austerity, audit commissions, a raft of integrity bodies, and Cabinet dynamics.
- Three to four-year "funding" programs with sunset clauses.
- "Policy on the run", meaning quick decisions taken based on what seems to be a good idea, but without evidence of how an opportunity is to be captured or a problem to be solved, and in isolation of interactions with other policies and programs (an innovation system "failure")
- Policy by announcement where policy initiatives go for maximum public relations exposure (spin) with little detail on the complexities of how policies are to be implemented.

8 Towards a coherent science, research, and innovation investment strategy

The Department of Industry, Science and Resources collects comprehensive data on Australia's SRI effort. But it is an after-the-event report. The data does not reflect the outcome of strategic intent: it aggregates hundreds of independent and uncoordinated investment decisions in multiple programs, departments and agencies (Green & Howard, 2015b).

No national economic development partnership exists between the national government and universities, either with specific institutions or across the board. Until the turn of the century, State Governments believed that funding universities was a Commonwealth Government matter. They concentrated on building occupational skills through the industry-focused state-owned Technical and Further Education Institutes.

8.1 A convincing narrative about the role of public research

This is a huge task, as there is a widely held perception that academics want to maximise their output of scholarly publications to secure their tenure and promotion prospects. The Publish or Perish mantra is alive and well[8].

The narrative must be developed from the perspective of the people or organisations that *receive* the communication—not from the perspective of people with a science or university research background who want to *tell* the world about the greatness of their research and scientific endeavour.

This approach might seem obvious, but there is a failure in current approaches to science communication.

8.2 A massive coordination problem

Engaging universities and public research organisations in a national economic development strategy is complicated as Australia does not have a national economic development strategy beyond the mining, agriculture, fisheries, and forestry commodity industries—sectors driven by powerful industry lobbies. Until the mid-1990s, manufacturing industry policy was driven by "infant industry" strategies but fell apart with the across-the-board removal of tariff protection as part of the Hawke-Keating microeconomic reform agenda.

Even defence industry manufacturing appears to be in disarray, with Australia privatising its defence production capability in the 1990s and relying on overseas defence purchases under questionable procurement strategies. Building defence industry capability often has more to do with politics than creating a vibrant defence industry to support Australia's national and security interests.

[8] See Howard, J.H,.2023. "Publish or Perish: Escaping the hamster wheel of academic research pursuits", *Pearls and Irritations*, 27 November 2023.

The lack of national policy interest in the manufacturing industry has been reflected in the revolving door appointments of eight Industry Ministers over the past eight years. Industry policy and strategy responsibilities are fragmented across 13 different portfolios, with an unfortunate separation between responsibilities for industry research (an industry portfolio) and applied academic research (in an education portfolio).

Fragments of a national manufacturing industry policy are only starting to emerge now through *Future Made in Australia*. But it must move beyond the rhetoric and pin down responsibility and accountability for the development and delivery of a clear strategy.

8.3 Clarifying roles and responsibilities

Initiatives to support research commercialisation and collaborations are beginning to emerge, commencing with standard agreements and trailblazer programs (with minimal money). The public research agencies have been committed to bringing research into application and use, and this should be supported much more strongly than it is.

Pushing responsibility for research commercialisation too far onto universities is risky. Australian universities are different from large US research universities with a track record in commercialisation. Large US research universities have the "space" for commercialisation. Only a handful of universities and public research agencies in Australia have a strong capacity and capability in this area.

There is a discontinuity in policy support in these areas: universities are the constitutional responsibility of the State Governments and the Commonwealth Minister for Education (for funding), while the publicly funded research agencies fall within the Ministerial responsibilities of the Ministers for Industry and Science, Defence, Health and Agriculture (and the Rural R&D corporations particularly). The policy continuity is overlooked or ignored as governments change, Ministers are promoted (demoted), and the Prime Minister decides to change the Administrative Arrangements Order.

8.4 A consistent and coherent public research investment model

An Australian research investment model must integrate all funding support for public research organisations—universities included.

Many other funding models are better than our hotchpotch of adhockery and discretion without a clear strategy. For example, NSF/NBER/NIH/DARPA in the US, Research and Innovation UK, and Science Foundation Ireland have been able to develop clear and coherent strategies.

The model should cover the roles of ministerial departments, public research organisations, medical research institutes, statutory bodies, and the States/Territories. It should also recognise a "portfolio" of funding streams for blue sky/basic/curiosity research, applied research, and experimental development. There should also be a stream to support innovation ecosystems.

The model should be informed by diverse innovation theories, not just the linear lab-to-market framework, but also web/network-based theory, start-up theory, open innovation, and user-centred innovation[9].

9 Policy implications and agendas

9.1 Policy reset

Australian and State/Territory *Ministers* must decide what they want from the public research system—principally universities, public research organisations, medical research institutes, and other research institutes across the R&D landscape—and how it is to be funded.

[9] See, Howard, John H,2023. Innovation theories as a model for govt policy, https://www.actoninstitute.au/post/innovation-theories-as-a-model-for-govt-policy

In 1959 Charles E Lindblom wrote his seminal article "The Science of Muddling Through" [10]. Lindblom argued that the U.S. executive bureaucracy uses incrementalism—limited policy analysis, bounded rationality, and limited or no theory at all—in formulating policy. The alternative is "root and branch analysis"

Lindblom suggested that "root and branch analyses" are more rigorous and robust and are possible and desirable within the context of an emergent complex adaptive political system framework. Such an approach provides more "analytical" justification and less "muddling through," yet because of the system's emergent nature, it may still require incremental implementation.

Root and branch analysis is not, in this context, the equivalent of land clearing and starting again. It simply implies that policymakers look at something in its entirety or from the bottom up.

In January 2024, the Report of the Australian Universities Accord recommended—

> 24. That the Australian Government commission a formal strategic, cross-portfolio examination of national research funding with a view to increasing Australia's capacity to maximise Australia's R&D competitiveness for economic gain, and environmental, cultural and social good. As part of this, the Australian Government develop a multi-agency government strategy that sets medium and long-term targets for Australia's overall national spending on R&D as a percentage of GDP, requiring a significant increase to ensure Australia fully utilises the potential of its research sector and, consequently, competes more effectively in the global knowledge economy. As a starting point, this work needs to note that while university investment in research has been strong over the last 25 years, additional business and government investment in research is essential. The strategy should also undertake a *root and branch* consideration of the suitability and sustainability of the national research funding and governance architecture

In May 2024 Minister Ed Husic's announced that the Government would "commission a strategic examination of Australia's R&D system to determine how we can get more value from every taxpayer dollar invested in research, maximise the contribution of science and R&D to the broader economy, and maintain our competitive edge".

This is a very welcome initiative and must not repeat the course of hundreds of other reviews in Science, Research and Innovation over the last 25 years.

9.2 What happens without change?

Without change, there are risks that the *status quo* will prevail with the following possible results—

- Universities will continue to compete globally based on eminence and prestige, which drives rankings and capacity to attract postgraduate students who do most of the research and generate citations. But the capacity to deliver breakthrough discoveries will suffer.
- Universities continue to cut costs on teaching to allocate more funds for research. Significant downstream implications include——
    - Teaching and learning become a commodity, driven by online delivery and increasingly outsourced.
    - Learning will trend towards "self-learning" for brighter students who enjoy a campus experience at heavily research-focused universities.
    - Low SES and low ATAR students missing out, without substantial policy interventions.
- Public research organisations will remain underfunded.
- Domestic businesses will continue to "under-invest" in R&D due to scale issues, limited "absorptive capacity", and limited access to scale-up and testing facilities. Overseas-

[10] Lindblom C.E 1959. "The Science of Muddling Through" *Public Administration Review* 19 (2) pp 79-88

owned larger businesses will continue to be subject to head office global research sourcing strategies and may continue to miss out on R&D investment.

9.3 Implementation and execution

Implementation and execution must address matters relating to how challenges and opportunities are to be met, for example, by considering—

- Separating funding streams for teaching and learning from research to eliminate the "teaching surplus" but allow for an overhead contribution.
- Aligning State/Territory TAFE teaching and learning funding with university funding
- Combining funding for HERD with support for public research agencies. Australia is too small to have multiple and potentially competing funding streams.
- Universities and PFRAs would compete for a larger pool of research funds on a merit basis, using the RSP's incentive framework. Collaborations would be encouraged and rewarded.
- Governments making long-term (10 years) commitments to increased funding for research; arrangements to be legislated.

Rigorous implementation may see—

- More specialised research institutes affiliated with several universities, public research organisations and industry. This could build on the Medical Research Institute model.
- The emergence of new delivery models —such as the NSW technology institutes.
- More active recruitment of Australian PhD students/graduates in areas of Australian industrial research strength and priorities—for example, advanced manufacturing, software engineering, fintech, and ag-tech.

9.4 Building commitment

The following policy implications flow from the analysis outlined above:

- Australia should also be more aggressive in encouraging and supporting international PhD graduates to remain in Australia to work with innovative Australian companies.
- Australian and State Governments should continue and extend their support for university-based and industry-focused independent research centres and institutes - such as the UNSW Sustainable Materials Research & Technology (SMaRT@UNSW) and the Institute for Frontier Materials at Deakin.
- Invest in infrastructure and support for viable and sustainable urban and regional innovation ecosystems – innovation precincts, hubs and districts based on smart specialisation principles. World-class research infrastructure investment (high-cost facilities, equipment, instruments) should be part of this equation.

10 A way forward: A National Research and Development White Paper

There is little doubt that the Australian research funding and delivery system is complex and appears disjointed and unconnected. But these characteristics also play out in other countries.

Comments are often made about the absence of coordinating machinery. But, as indicated on page 6, this exists at the Ministerial level within the Government's terms of reference for the National Science and Technology Council. The specific terms of reference are to provide:

> ... tangible and timely advice to the Government on:
> - long-term and emerging scientific and technological developments;
> - scientific and technological issues of relevance to Government policy or priorities;
> - Australia's science system, including issues relating to science engagement, research capability and science, technology, engineering and mathematics (STEM) education and workforce skills;

- achieving the Government's objectives as set out in the National Science Statement; and
- other matters requested by the Prime Minister, other ministers, or considered important by the Council.

The Prime Minister is the Chair of the Council, and the Minister for Science is the Deputy Chair. The Chief Scientist and the CEO of CSIRO are members, with six scientific expert members.

All of the currently appointed expert members are linked to the research community. Given the significance of business R&D to Australia's economic and industrial future, there is a strong argument for appointing an eminent scientist from the business community to the Council.

Under our Westminster System of government and public administration, Ministers are responsible for developing research strategies for the Government and their portfolios in their individual capacities. They should be encouraged to do this, and they should do this collectively within a Science, Research and Development Subcommittee of Cabinet[11].

Strategies should come together in a national *Research and Development Policy White Paper*[12] that sets out missions, challenges, strategies, objectives, and implementation detail, defines responsibilities and accountabilities and contains meaningful performance measures.

The White Paper process should replace the steady stream of announcements, actions, and intentions relating to program initiatives in glossy brochures and booklets. The White Paper should acknowledge the missions and strategies of State and territory governments.

The White Paper must go beyond publicity and spin and be accessible to all participants in the research and development system.

[11] The most recent UK Industrial Strategy, *Building a Britain Fit for the Future*, was issued as a White Paper by HM Government but prepared by the Rt Hon Greg Clarke, Secretary of State for Business, Energy and Industrial Strategy.
[12]See Percy Allan, 2018. Process, not policy is where the left and right can agree. *The Mandarin*, 16 October 2018, https://www.themandarin.com.au/99997-percy-allan-process-not-policy-is-where-the-left-and-right-can-agree/

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