GROUP OF EIGHT AUSTRALIA

Australia's Research and Development (R&D) Intensity:

A Decadal Roadmap to 3% of GDP

Group of Eight (Go8) Universities Report to the Australian Government

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Foreword

Australia, like economies around the globe, is grappling to navigate complex policy challenges to deliver short term cost of living relief while setting the nation up for a prosperous future.

It is in all our interests to ensure a prosperous Australia where economic, social, and environmental opportunities are achieved and challenges addressed.

The key to that prosperity relies on being an innovative and productive nation. Unlocking that capacity is influenced by many factors – not the least of which is research and development (R&D).

Increased R&D investment is a key element of successful modern economies. This is why the Group of Eight (Go8) universities support the Australian Government's 2024–25 Budget announcement that it will conduct a *Strategic Examination of Australia's Research and Development system*, to grow R&D and build a more resilient and dynamic economy.

Recognition of the importance of R&D is the first step, and actions to drive this important form of nation building investment are the next step. **This report is about actions based on evidence.**

Australia's R&D intensity … has been in decline for over a decade, at a time when productivity growth has been patchy and advanced economies have been investing heavily in R&D to boost their long-term prospects. The result is a growing gap between our R&D performance and that of advanced OECD economies.

Australia's R&D intensity (R&D expenditure as a percentage of GDP) has been in decline for over a decade, at a time when productivity growth has been patchy and advanced economies have been investing heavily in R&D to boost their long-term prospects. The result is a growing gap between our R&D performance and that of advanced OECD economies.

If Australia fails to make optimal investment in R&D today, the negative impact on Australia's productive capacity will be longlasting.

This is why the Go8, Australia's top 100 globally ranked research intensive universities is calling on the Australian Government to adopt an ambitious 10-year Roadmap of policy reforms to lift R&D intensity to 3 per cent of GDP by approximately 2035. The policy reform focus is especially on the business sector given that it contributes over half of all R&D expenditure in Australia, but its share of total R&D expenditure has gradually declined.

Universities – in particular our research-intensive universities – have picked up the slack and expenditure by the higher education sector on R&D has steadily increased from 0.40 per cent of GDP in 2000, to 0.61 per cent of GDP. But there's a limit to how much our universities can contribute to R&D, given our reliance on government and international student fee revenue.

Universities – in particular our research-intensive universities – have picked up the slack and expenditure by the higher education sector on R&D has steadily increased from 0.40 per cent of GDP in 2000, to 0.61 per cent of GDP.

Group of Eight (Go8) universities are responsible for 70 per cent of the research conducted by Australian universities, investing $7.7 billion annually. This represents 20 per cent of the total national investment in R&D by business, governments, and the higher education sector combined.

Foreword

The R&D target is not about Australian Government spending – it is a ***national target*** requiring private investment and public sectors to work together. We recognise an R&D intensity target is not an objective in itself, rather R&D intensity is a strong indicator of an economy's long-term innovation and productivity potential.

Our Roadmap consists of a dozen evidence-based and fiscally responsible policy reforms to be implemented over a ten-year period.

... the Go8 has developed a roadmap of policy reforms to lift R&D intensity to 3 per cent of GDP by 2035. It is an ambitious timeframe but universities are in the 'solutions business'.

It starts with the Australian Government setting a clear national purpose and direction – by formally adopting a target of 3 per cent of GDP invested in R&D by 2035 – and including this target in its *Measuring What Matters Framework*.

To support setting a national target, the Australian Government should implement the set of policy reforms outlined in our Roadmap to drive progress towards the target.

After more than six months of intensive effort, workshops with government, business and industry experts and drawing on world's best practice, the Go8 has developed a roadmap of policy reforms to lift R&D intensity to 3 per cent of GDP by 2035. It is an ambitious timeframe but universities are in the 'solutions business'.

This is a nation building exercise and it should be a national priority. Investment in R&D is an investment in the future of Australia.

We thank the following for their contribution and advice:

- The Go8 Project Advisory Group: Professor Emma Johnston AO, University of Sydney, and Dr Dean Moss, University of Queensland.
- The Go8 Economics Advisory Group, consisting of leading economists.
- Standing Go8 Working Groups with experts in research, innovation and commercialisation.

- Australian Government officials from the Department of Industry, Science and Resources; the Treasury; the Department of Education; and the Department of Health and Aged Care.
- Business sector representatives including: the European Australian Business Council (EABC), the Business Council of Australia (BCA), Ai Group, the Australian Chamber of Commerce and Industry (ACCI), and the Council of Small Business Organisations Australia (COSBOA).
- The National Research and Innovation Alliance (NRIA).

We look forward to engaging with the Australian Government on progressing the national effort to enhance Australia's innovation and productivity capacity through lifting R&D intensity.

Vicki Thomson
Chief Executive

Executive Summary

This report is a call to action on a critical aspect of Australia's national innovation system – research and development (R&D). R&D expenditure is one important investment input and, along with its widespread adoption, enhances the capacity of Australia to achieve sustained productivity growth through innovation.

Australia's recent productivity growth performance has been patchy while overall R&D intensity, (defined as R&D expenditure as a per cent of Gross Domestic Product) has been declining from approximately 2.25 per cent in 2008–09 to an estimated 1.68 per cent in 2021–22.

Without a reversal of the downward trend, Australia's long-term innovation and productivity capacity will be hampered, and the priorities identified in the *Intergenerational Report 2023*, will be more difficult to achieve. Australia needs to adopt a formal national R&D intensity target and implement a set of policies to achieve it over a horizon of approximately a decade.

Empirical evidence shows that Australian R&D supports high societal returns – an average economy-wide return of $3.50 for $1 of R&D investment. In addition, estimates for Australia indicate a societal optimal R&D intensity above 3 per cent of GDP, providing sound economic justification for such investment in Australia's long-term innovation capacity.

Projections suggest an R&D intensity target of 3 per cent of GDP can be achieved over a 10 year period if we can return to strong R&D investment across all sectors. **This is not a target for Australian Government spending – it is a national target requiring private and public sectors to work together**.

As a nation, just over half of all R&D expenditure comes from the business sector but its share of total R&D expenditure has gradually declined. We need stronger investment by the business sector to lift our R&D intensity, supported by higher education and government sectors.

Failure to achieve optimal investment in R&D today will mean the negative impacts on Australia's innovation capacity and productivity is experienced many years into the future.

Our Roadmap to lift R&D intensity is based on an "innovation policy toolkit" that identifies and assesses the international evidence on the effectiveness of various existing and comparable innovation related policies. These policy reforms, focussed specifically on lifting R&D investment, are intended to complement broader policy settings conducive to investment and economic growth.

The Roadmap starts with setting a clear national purpose and direction – that is, **the Australian Government should formally adopt a target of 3 per cent of GDP invested in R&D by 2035**, and include this target in its *Measuring What Matters Framework* with commensurate reporting on progress. Estimates of the optimal level of R&D for Australia provide economic justification for the target, which will also serve as a motivator for reforms to boost Australia's innovation and productivity capacity.

We recognise that an R&D intensity target is not an objective in itself, but R&D intensity is a strong indicator of an economy's long-term innovation and productivity potential. The Australian Government should report annually on progress to achieve the target and also invest in improved measurement of the outcomes of publicly funded R&D.

After setting a national target, the following reforms should be implemented over the short, medium and long term:

Failure to achieve optimal investment in R&D today will mean the negative impacts on Australia's innovation capacity and productivity is experienced many years into the future.

Short term (1–2 years):

- Expand the current Business Research and Innovation Initiative (BRII) by introducing a Small Business Technology Transfer (STTR) type program to incentivise SMEs to engage with Australian research institutions on R&D collaboration.

Under the new Skills in Demand visa as part of the Migration Strategy*, provide direct and expedited permanent residency for international students obtaining a PhD at an Australian university.*

- Leverage the Research and Development Tax Incentive (R&DTI) by offering an additional equity or debt finance incentive from the National Reconstruction Fund (NRF) to businesses that qualify for the R&DTI and enter into formal R&D collaboration with an Australian research institution.
- Boost Australia's R&D workforce through skilled migration:
  - » Under the new Skills in Demand visa as part of the *Migration Strategy*, provide direct and expedited permanent residency for international students obtaining a PhD at an Australian university.
  - » Through the new National Innovation visa, include specific provision for the attraction and retention of high-quality international researchers.
- Further invest in the domestic R&D workforce by:
  - » Prioritising reforming university funding rates and levels for STEM related fields of education to raise STEM supply through universities.
  - » Ensuring stipends and scholarships for higher degree by research students are attractive to retain and grow the pool of researchers in Australia.

- On the basis of a government review underway, boost the effectiveness of the *Higher Education* Research *Commercialisation Intellectual Property Framework* by revising the template agreements provisions to address inappropriate liability provisions and unreasonable intellectual property indemnities for universities as public institutions. Maintain these agreements as voluntary to use.

Medium term (3 to 5 years):

- Facilitate the presence of additional intermediaries and aggregators (between superannuation funds as investors and early-stage enterprises as investees) to encourage expenditure in R&D by superannuation funds.
- Facilitate further collaboration between businesses and the research sector, including:
  - » Strengthening the National Collaborative Research Infrastructure Strategy program by adopting a life-cycle approach to funding for national research infrastructure; specifying a requirement to aim for productive engagement and partnerships between researchers, industry and the broader community; and including explicit provision for researchers to access priority international research infrastructures.

Facilitate the presence of additional intermediaries and aggregators (between superannuation funds as investors and early-stage enterprises as investees) to encourage expenditure in R&D by superannuation funds.

  - » Pursue Australia's participation in globally leading-edge research consortia and collaborations (such as Horizon Europe).
- On the basis of the Treasurer's recently announced *Competition Review*, ensure that proposals for reform explicitly consider implications for long-term innovation in Australia and rebuild the momentum achieved by previous competition policy reforms. In addition, where appropriate in the Australian context, implement Productivity Commission recommendations to progressively remove Australia's anti-dumping and countervailing measures; increasingly accept product standards adopted in other leading economies as 'deemed to comply'; and reduce non-tariff barriers to trade in services.

Long term (6 to 10 years):

- Establish a fund similar in scale to the Medical Research Future Fund (MRFF) focussed on fields of research outside of the MRFF.
- Work with States/Territories and local government to coordinate existing programs and support to incentivise development of knowledge precincts through co-location of Australian universities and businesses.
- Implement open access to research principally funded by the Australian Government in a way that does not result in extraction of rents by publishers from researchers and readers, but acts to increase knowledge available to businesses and improve diffusion of knowledge.

By implementing our Roadmap of reforms to raise Australia's national R&D intensity, the Australian Government can drive Australia's innovation and productivity potential that underpins our future prosperity. **Now is the time for action.**

1 Introduction

This report is a call to action on a critical aspect of Australia's national innovation system – research and development (R&D) intensity (defined as R&D expenditure as a per cent of Gross Domestic Product). Investment in R&D, along with its widespread adoption, is one important input to enhance Australia's capacity to achieve sustained long-term productivity growth through innovation and the prosperity that productivity brings.

We welcome the Australian Government's 2024–25 Budget announcement that it will conduct a *Strategic Examination of Australia's Research and Development System*, to grow R&D and build a more resilient and dynamic economy. Recognition of the importance of R&D is the first step, and actions to drive this important form of nation building investment are the next step. This report is about actions based on evidence.

The Australian Government has identified several significant long-term shifts that will influence Australia's economic prosperity for decades to come, notably: an ageing population and rising demand for support services, the impacts of digital transformation, climate change and the need to achieve a net zero transformation, and ongoing geopolitical risks. Efforts are underway to address these long-term shifts, including through government funding, programs and initiatives such as the recently announced *Future Made in Australia* agenda.

Successive Intergenerational Reports have highlighted the 3Ps framework (Productivity, Participation, and Population) as a pathway to economic growth and prosperity. Under this framework, in the long term, productivity is the most critical of the three factors, and therefore also the means through which to address Australia's broader social and environmental challenges and opportunities.

Section 1: Introduction

Australia has not been immune to the global lacklustre productivity performance in recent years, but the question is what do we do about it?

In other words, the more you invest in both knowledge creation and human capital, the larger the potential economy-wide productivity return.

The elusive quest for sustained and significant long-term productivity growth has resulted in a wide range of policy drivers being identified and implemented – everything from physical infrastructure investment, new technologies, business management practices, trade openness and diversity, the changing industry structure of the economy, the quality of institutions, the 'digital' economy broadly defined, and even geography.

The capacity for an economy to achieve sustained long-term prosperity relies partly on innovation (i.e., doing more or better with the same inputs) and human capital (the skills to turn innovative ideas and knowledge into productive changes to goods and services). In other words, the more you invest in both knowledge creation and human capital, the larger the potential economy-wide productivity return. This is recognised by the Productivity Commission (2022): *"While economic growth based solely on physical inputs cannot go on forever, human ingenuity is inexhaustible"*.

Productivity and innovation capacity is in turn partly related to a nation's R&D intensity and performance.[1] R&D intensity is defined at a national level

1 The OECD (2013) highlights innovation related assets other than R&D, including computerised information (such as software, databases), economic competencies (such as worker training, and better management practices), and innovative property other than R&D (such as copyrights and creative assets, improved knowledge on minerals exploration, and new architectural and engineering designs).

as expenditure on R&D as a per cent of GDP, both in nominal dollars.[2]

R&D is a crucial factor because it has features other forms of investment do not (such as non-rivalry and to some extent non-excludability) and this helps create knowledge spillovers that underpin "social rates of return" beyond the "private rates of return" to entities directly conducting or financing the R&D.

Together with investment in human capital, this form of knowledge creation and diffusion can underpin increasing returns to scale (that is, when knowledge and human capital are together increased by a given proportion, the amount that can be produced increases by a larger proportion).

R&D contributes to innovation and productivity capacity in several ways. For example, firms use external knowledge to become more productive. R&D expenditure creates and raises the returns on knowledge spillovers, which leads to innovation, and R&D can create collaboration between sectors. As the International Monetary Fund (IMF, 2021) notes: *"…research increases knowledge, knowledge enhances productivity, and productivity determines how much final output is generated from real inputs."* Therefore, R&D matters to productivity.

As the International Monetary Fund (IMF,2021) notes: "…research increases knowledge, knowledge enhances productivity, and productivity determines how much final output is generated from real inputs."

2 While at the industry or sectoral level R&D intensity is often defined as expenditure on R&D by that industry as a percentage of value added for that industry, for the purposes of this report, we define it to be expenditure on R&D by that industry as a percentage of GDP, so that the sum of the industry R&D intensities equals the national R&D intensity figure.

Go8 universities *alone* contribute more than a fifth of Australia's overall expenditure on R&D, propping up the national effort at a time when Australia's overall R&D intensity has been steadily declining from approximately 2.25 per cent in 2008–09, to an estimated 1.68 per cent in 2021–22.

Without a reversal of this trend, the priorities identified in the *Intergenerational Report 2023*, will be more difficult to achieve. If we fail to make optimal investment in R&D today, the negative impact on innovation capacity and productivity will be experienced many years into the future.

How does Australia reverse the trend of declining R&D intensity at a time when we need more domestic knowledge creation, innovation, and productivity to tackle the challenges outlined in the IGR 2023?

This Go8 Report takes the initiative to drive the discussion between the Australian Government and business, industry, universities, and research institutes to raise Australia's expenditure on R&D to 3 per cent of GDP. This is not a target for Australian Government spending – it is a national target that private and public sectors must work together to achieve.

Without a reversal of this trend, the priorities identified in the Intergenerational Report 2023*, will be more difficult to achieve. If we fail to make optimal investment in R&D today, the negative impact on innovation capacity and productivity will be experienced many years into the future.*

We propose a decadal "Roadmap" of strategic policy reforms that starts with the Australian Government updating the *Measuring What Matters Framework* to formally adopt, as a national priority, a target of 3 per cent of GDP invested in R&D by 2035. These focussed policy reforms aimed at lifting R&D investment are intended to complement broader policy settings conducive to investment and economic growth. These include a taxation system that promotes labour market participation and entrepreneurship while also attracting foreign direct investment; investment in the quality of education at all life stages; and addressing the recommendations of the Australian Universities Accord Review Panel related to research funding. As the International Monetary Fund (2024, p. 40) notes: "Complementary structural, competition, trade, and financial policies are needed to provide a level playing field, avoid concentration of market power, and ensure adequate access to financing along the innovation cycle."

This Report describes:

- The importance of R&D to economic growth and prosperity (Section 2).
- Australia's current R&D intensity performance relative to socially optimal levels (Section 3).
- Projections of Australia's R&D intensity through various scenarios (Section 4).
- Discusses policies to enhance Australia's R&D intensity and innovation using an "innovation policy toolkit" (Section 5).
- Brings the discussion together into a Roadmap of recommendations to the Australian Government (Section 6).

Section 7 provides concluding comments.

2 Why does Australian R&D matter?

R&D expenditure, along with its widespread adoption, is an integral factor contributing to Australia's capacity for innovation and productivity, which are the longterm sources of growth and prosperity.[3] According to the International Monetary Fund (2021):

"...research increases knowledge, knowledge enhances productivity, and productivity determines how much final output is generated from real inputs."

The general nature of research, and in particular basic research, is non-rivalry (its use by one person or business does not preclude use by another person or business). This means research can result in productivity 'spillovers' – it also means that the benefits of the research cannot be totally appropriated, and because of this a given business may decide to invest in less than is socially optimal in such R&D (International Monetary Fund, 2024). Moreover, given the uncertain and often long lead time for some R&D to materialise into commercial returns, businesses may be reluctant to invest and/or have difficulties accessing credit for such investments.

These market imperfections provide the basis for government support. **But the onus is not entirely on governments**: the private sector is the biggest contributor of R&D activity, and the higher education sector also has an important role to play in boosting Australia's innovative capacity.

In 2021–22, total R&D expenditure in Australia was an estimated $38.75 billion in nominal dollar terms, including:

3 The distinction between innovation and productivity is that productivity relates to the efficiency of a production process whereas innovation leads to changes in efficiency so that innovation is a determinant of productivity (Shu & Steinwender, 2019).

- $20.64 billion by businesses, accounting for 53 per cent of total R&D expenditure in Australia.
- $12.97 billion by higher education institutions, accounting for around 33 per cent of total R&D expenditure in Australia.[4]
- Just over $5 billion by government and private non-profit organisations together (approximately 14 per cent of total R&D expenditure in Australia).

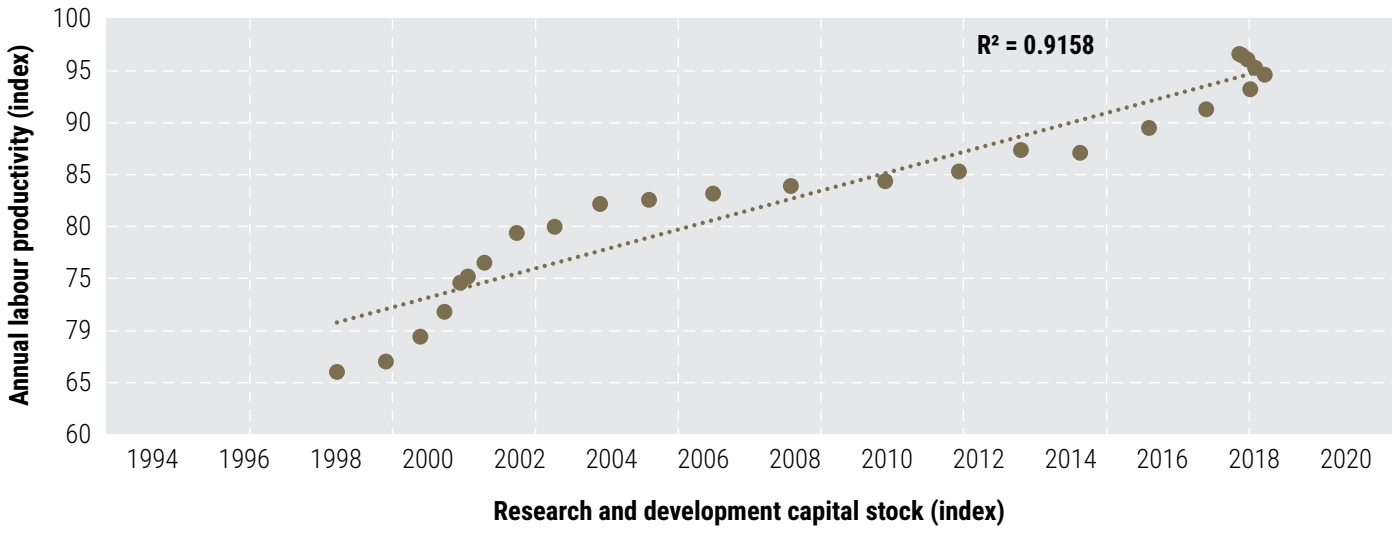
Different sectors specialise in different types of R&D and therefore complement each other. For example, R&D investment by universities tends to be concentrated in basic or fundamental research with around 60 per cent of all expenditure on basic research from this sector, compared to around 15 per cent from the business sector. In this way, universities tend to focus on "new to the world" knowledge creation. In contrast, businesses tend to concentrate on "experimental development", contributing around 84 per cent of total spending in this area, compared to under 10 per cent from the higher education sector.

Chart 1 shows the positive association between annual labour productivity growth for Australia (real gross value added, divided by hours worked) and the real R&D capital stock (net end of year).

In 2021–22, total R&D expenditure in Australia was an estimated $38.75 billion in nominal dollar terms

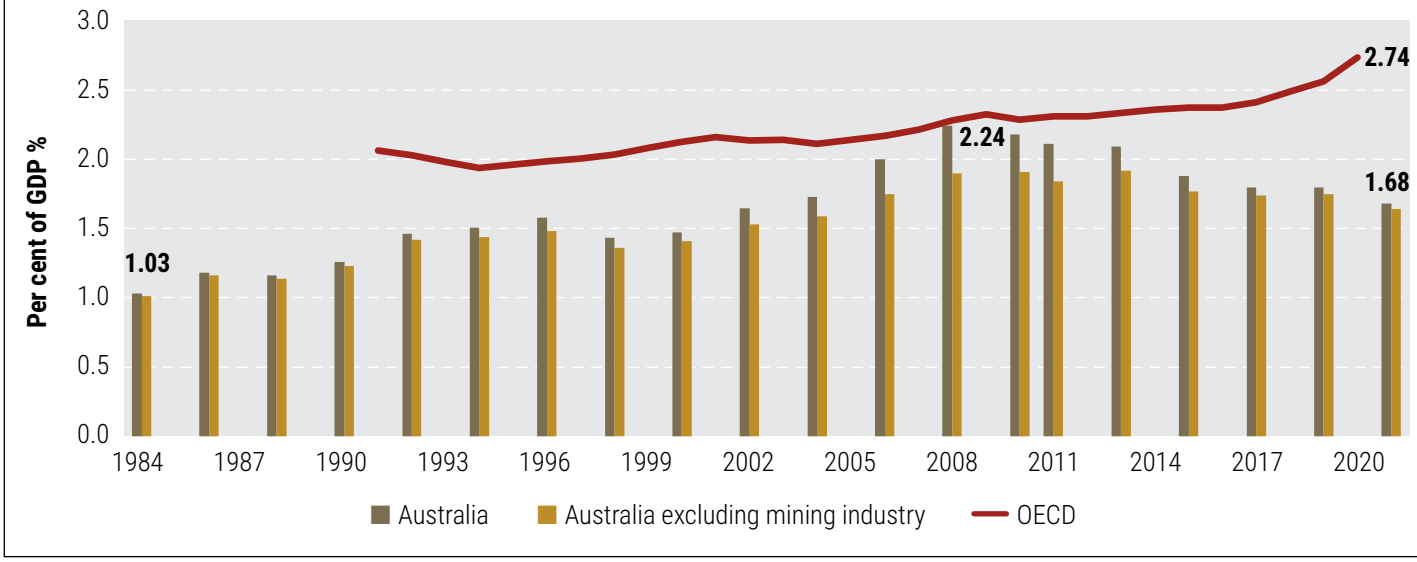
4 The $12.97 billion figure is an estimate for 2021–22 from the Australian Bureau of Statistics (ABS). The ABS has more recently published a figure for calendar year 2022 of $13.99 billion.

Chart 1: Annual labour productivity and the R&D capital stock in Australia



Data sources: ABS (2023), Australian System of National Accounts, tables 15 and 56. Data are from 1994–95 to the beginning of COVID-19 period.

Chart 2: Total R&D expenditure as a per cent of gross domestic product (GDP)



Data sources: ABS and OECD MSTI database.

Cumulative investment in R&D adds to the stock of "knowledge" that can be used as an input to innovation and productivity. Basic research in particular is a long-term investment because it does not necessarily deliver immediate returns, with practical and commercial applications potentially realised much later. This means the impact of R&D investment can have long lag times, and it is for this reason that failing to make optimal investment in R&D at the present time will mean the negative impact on innovation capacity and productivity is experienced many years into the future.

The Productivity Commission (2023a) has recently highlighted Australia's long-term productivity challenge with average annual labour productivity growth in Australia over the decade to 2020 at 1.1 per cent, the slowest in 60 years compared to average annual growth of 1.8 per cent over the 60 years to 2019–20. The slowdown in annual labour productivity growth has occurred at a time that Australia's R&D intensity has fallen (Chart 2).

Chart 2 also shows Australia's performance *excluding R&D expenditure by the mining industry*, illustrating the strong contribution to R&D intensity from the mining industry from the early 2000s, followed by the period since late 2000s where the mining industry's contribution to overall R&D expenditure has been less pronounced. **We can see that over the past decade, excluding mining, there has been a decline in national R&D intensity.** Appendix A further discusses the sectoral composition of Australia's R&D performance given in Chart 2.

Underlying Chart 2 is also a relative change in expenditure on different types of R&D. The share of basic research has become less pronounced as applied research and experimental development have become more prevalent. One explanation for this change is that it reflects a positive reorientation to more tangible and applicable commercial uses of R&D effort. However, sometimes without basic research, applied research is not feasible – basic research can be a necessary precursor to applied research and/or commercialisation.

As the International Monetary Fund (2021, p. 66) emphasises: ***"Basic scientific research is a key driver of innovation and productivity, and basic scientific knowledge diffuses internationally farther than applied knowledge."***

includes both extramural support and intramural expenditure, including support through R&D tax incentives).

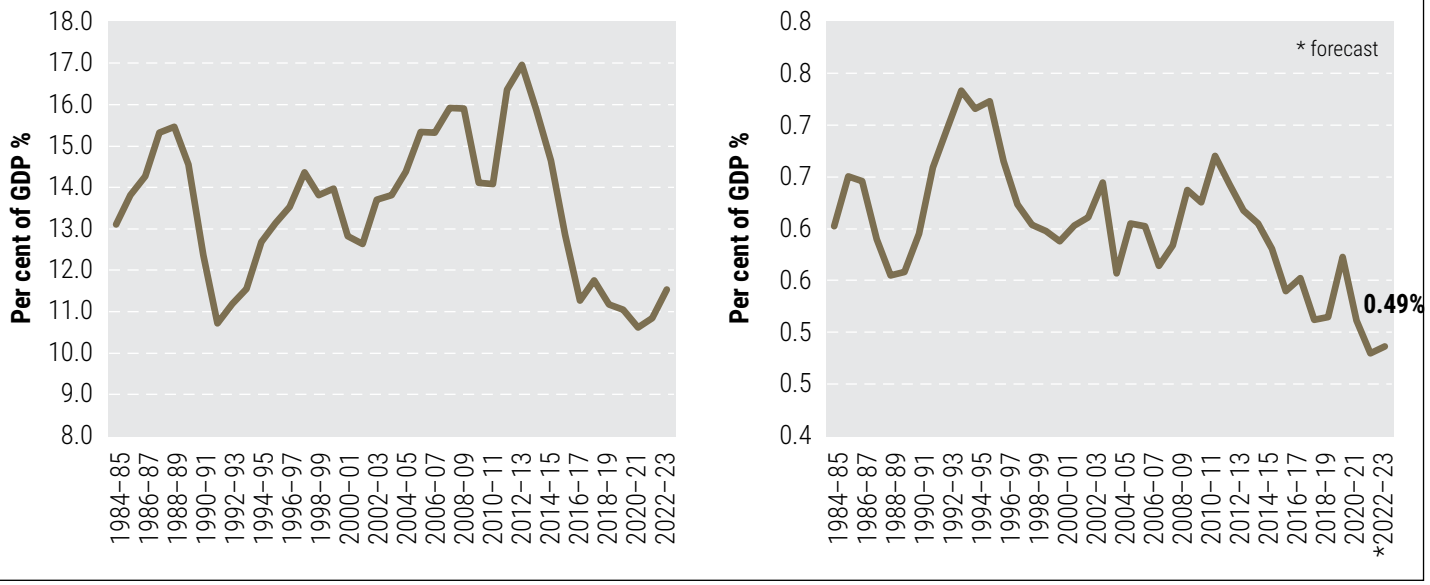
The left side of Chart 3 shows the decline in total private sector business investment as a per cent of GDP from around 2008–09. Given the

Given the prominent role of the business sector in overall R&D activity, reversing this decline in overall investment as a share of the economy is one of the most critical challenges to lift stocks of both traditional physical capital and "intangible" R&D capital.

Underpinning the overall decline in Australia's R&D intensity has been a decline in total private sector business investment (of which R&D investment is only around 7 per cent) as a per cent of GDP (Chart 3). The right side of Chart 3 provides Australian Government total R&D investment as a per cent of GDP (i.e., this figure

prominent role of the business sector in overall R&D activity, reversing this decline in overall investment as a share of the economy is one of the most critical challenges to lift stocks of both traditional physical capital and "intangible" R&D capital. The 2024–25 Budget suggests there has been a recent pick-up in business investment

Chart 3: Total private sector business investment (left) and Australian Government (right) total R&D investment (per cent of GDP)



Data sources: ABS – Australian National Accounts: National Income, Expenditure and Product. Australian Government Science, Research and Innovation Budget Tables, 2023–24.

and the forecasts suggest this will continue through to 2025–26 (Australia Government Department of Treasury, 2024). It is important that these forecasts of stronger growth come to fruition, including investment in R&D.

In the period from the mid-1980s, total Australian Government investment in R&D peaked at 0.73 per cent of GDP, but since then there has been a gradual decline to a forecast 0.49 per cent of GDP in 2023–24. Australian Government total R&D investment is reflected in 157 government programs with 90 per cent of funding delivered through 18 large programs ($100 million or greater).

Empirical evidence on the importance of R&D to innovation and productivity

We are not claiming here that R&D is the *only* factor in Australia's productivity performance – rather that it is one critical factor to Australia's capacity for innovation and productivity.

The evidence on the broad benefits of R&D is clear cut. The OECD (2015) states: *"Social rates of return to R&D generally prove to be significantly larger than private returns, the average (median) social return to R&D amounting to roughly 1.2 (0.8). On average, spillover benefits make up for approximately 61% (median 67%) of the social return to R&D"*.[5] Other recent studies that examine investment in R&D as a driver of productivity growth are similarly positive.[6]

Australian specific evidence: An average economy-wide return of $3.50 for $1 of R&D investment in Australia

The CSIRO has quantified the relationship between domestic gross expenditure on R&D and Australian GDP per capita growth to estimate the return on investment (ROI) to innovation. Specifically, the CSIRO estimates a significant benefit-cost ratio of 3.5 to R&D investment, assuming a conservative lag of 10 years between the research activity and the economic returns, as well as allowing for R&D embodied in physical capital.

- Elnasri & Fox (2017) indicate strong support for the productivity benefits from higher education R&D amongst four classes of public funding for research and innovation in Australia. In particular, the elasticity of multifactor productivity

5 Social refers to economy-wide and broader indirect impacts. In contrast, private refers to direct impacts to those directly involved in a transaction or activity.

6 Recent studies are discussed in van Ark, B, de Vries, K, & Pilat, D. (2023). 'Are pro-productivity policies fit for purpose?' Working Paper No. 038, The Productivity Institute.

(MFP) with respect to public funding of higher education R&D is 0.175, which means an increase of 1 per cent in public funding on higher education R&D can increase MFP by 0.175 per cent.

- Evidence from Bakhtiari & Breunig (2017) also suggests positive local R&D spillovers in Australia and that R&D expenditure specifically by university researchers, has a positive impact on a firm's own R&D expenditure within the same Australian jurisdiction.

Apart from these economy-wide studies, individual case studies also demonstrate the importance of R&D to innovation and productivity. The following are case studies of collaboration on university R&D that have resulted in commercial success in Australia.

Box 1: Examples of successful collaboration on R&D

- The University of Queensland and CSL for the HPV vaccine case study:

  https://www.nhmrc.gov.au/about-us/resources/impact-case-studies/gardasilr-hpv-vaccine

- The University of New South Wales and ResMed with sleep apnea (CPAP device):

  https://www.nhmrc.gov.au/about-us/resources/impact-case-studies/breathing-easier-during-sleep-case-study

Addressing the scepticism about needing to invest more in domestic R&D

Argument: We can rely on adopting and adapting existing research and knowledge

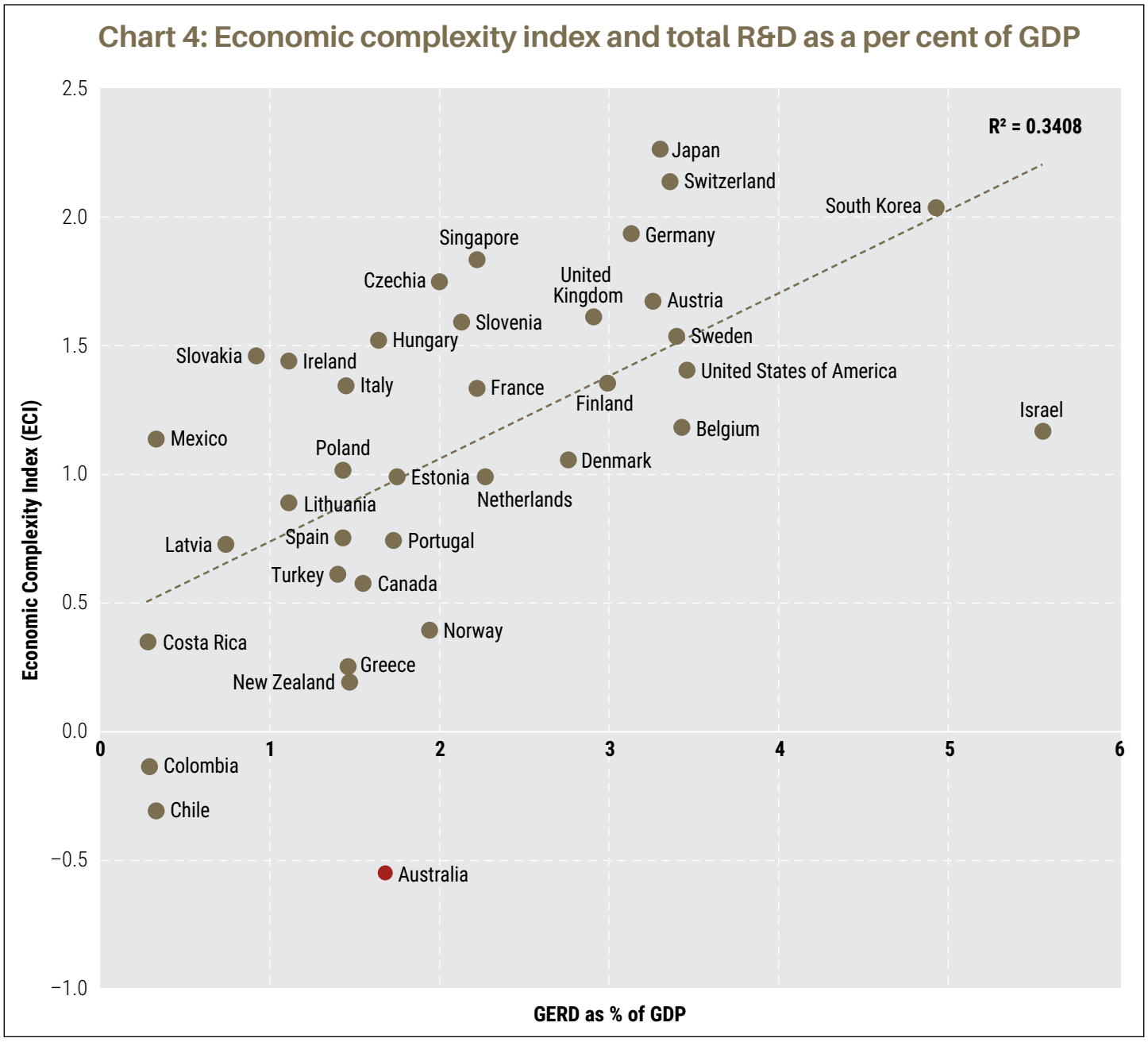
One view is that Australia's R&D intensity is not an issue when we can continue to adopt and adapt existing R&D (or knowledge more broadly), including from overseas. That is, we can 'buy it in". This recognises the global nature of R&D, however it ignores the following – with some risk:

- The stock of existing R&D or knowledge (including that from overseas) may not suffice to meet Australia's unique emerging opportunities and challenges, so that new and domestic investment in R&D and knowledge may be required. The OECD (2015), for example, suggests that the economy-wide payoffs for R&D conducted in the home country are much higher than those derived from R&D conducted in other countries.
- There may be lags involved before R&D performed overseas can be adopted and absorbed in Australia, negatively impacting Australia's competitiveness. Also, with complex R&D and knowledge there needs to be an existing domestic capacity (research workforce) for Australia to have an ability to effectively absorb and adopt that knowledge produced overseas. That workforce may not be large enough if domestic R&D intensity is declining.

In other words, Australia does not have to be a follower and is, and can continue to be, a world leader in many fields of new knowledge creation and dissemination. For example, six of Australia's leading research institutions, including Go8 universities the University of Melbourne and Monash University, and the CSIRO, have entered into international agreements to address clean energy production and storage (CSIRO, 2023).

The risk of low R&D intensity to international (export) competitiveness, and in turn economic complexity, is illustrated

in Chart 4, which shows Australia's relatively low R&D intensity of 1.68 per cent of GDP is associated with a low economic complexity index, which is a function of the diversification and competitiveness of a nation's exports.



Data sources: Harvard Kennedy School Growth Lab and OECD MSTI database.

Further issues with relying on an 'adopt and adapt existing research and knowledge' approach include:

- R&D investments by multinationals may assist Australia's productive capacity, but if the gains are captured mostly in multinational profits channelled back overseas, then domestic returns to acquired R&D may be less than if the R&D had been undertaken domestically.
- In a world of geopolitical competition and fragile supply chains, we have sovereign capability needs that will require domestic R&D investment.

It is not a binary choice – Australia can be a more sovereign nation while also benefitting from adoption and adaption of existing overseas innovation.

This is not to diminish the scale and benefits of businesses in Australia adopting and adapting existing research and knowledge, including R&D embedded in technologies and capital equipment from overseas. Rather, and importantly, it is a recognition that Australia is not solely reliant on the stock of existing R&D and knowledge for its productivity revival. It is not a binary choice – Australia can be a more sovereign nation while also benefitting from adoption and adaption of existing overseas innovation.

We are not suggesting that by Australia not relying entirely on foreign or acquired R&D we should undertake R&D in every industry or business. Domestic business R&D efforts should continue to be based on comparative advantage and sound assessment of opportunities.

Argument: We can have innovation without research

Another sceptical view of the need to invest more in domestic R&D is that innovation depends on more than R&D, with R&D being only one input to the process of innovation and that we can have "innovation without research" (World Intellectual Property Organization, 2022). According to this view, non-R&D expenditure and

activities include the development of software, the adoption of new business models, acquisition of intellectual property and/or purchase of 'innovation-related' machinery and equipment, or new branding and marketing. Proponents of this broader view of innovation suggest these activities are just as important as formal R&D to Australian businesses innovation, especially smaller businesses that do not invest much in formal R&D (AlphaBeta, 2020).

The argument that the prevalence of non-R&D expenditure and activities means R&D intensity is less of a concern for Australia ignore several factors. First, many of these non-R&D activities merely describe the application of R&D based innovation conducted elsewhere. For example, when a small business acquires new technologically advanced machinery and equipment, that machinery and equipment will have "embedded" in it R&D conducted elsewhere. Therefore, it is the underlying R&D that is driving the adoption by the small business to take advantage of that R&D encapsulated in the machinery and equipment.

The process of acquiring technologically advanced machinery and equipment is "capital deepening" but the physical equipment is likely to be rivalrous and excludable – meaning that it does not produce the same knowledge spillovers and increasing returns to scale from non-rivalrous research and development activities. Therefore, it may well be in the private interests of individual Australian businesses to invest in non-R&D activities, but from a societal perspective, it is R&D that produces knowledge spillover and is the basis for increasing returns to scale, which matters more.

We are not suggesting that by Australia not relying entirely on foreign or acquired R&D we should undertake R&D in every industry or business. Domestic business R&D efforts should continue to be based on comparative advantage and sound assessment of opportunities.

More broadly, national accounts data on these forms of broader investment in "intellectual property products" suggests that, like R&D expenditure, these broader forms of investment in Australia have been trending downwards over time. For example, Australian investment in "intellectual property products", excluding R&D, declined from 1.44 per cent of GDP in 2000–01 to 1.11 per cent of GDP in 2022–23. International comparisons of innovation activities also suggest that investment by Australian businesses in broader innovation (non-R&D) lags developed economy averages (AlphaBeta, 2020). So non-R&D investment has not compensated for the decline in R&D intensity in Australia.

Australian investment in "intellectual property products", excluding R&D, declined from 1.44 per cent of GDP in 2000–01 to 1.11 per cent of GDP in 2022–23.

Argument: Our industry composition and cyclical factors explain our relatively low R&D intensity

Another argument is that business expenditure on R&D in Australia is relatively low compared to other countries and this mainly reflects Australia's industry structure. (Davis & Tunny, 2019). For example, Australia has a smaller manufacturing sector relative to other economies (with the manufacturing industry being a traditional source of R&D expenditure). Another factor suggested is that Australia's mining industry's investment in R&D peaked in the first decade of this century and has since declined with the cyclical shift to production (AlphaBeta, 2020). The role of the mining industry in R&D during the 2000s is evidenced by Chart 2.

Industry sector mix and cycles of mining investment together do explain some of the decline in Australia's R&D intensity from the late 2000s onwards. It is true that the challenge of significantly lifting national R&D expenditure would be easier if we had another mining investment boom,

but industry sector mix and cycles of mining investment are not reasons to resign Australia's capacity to create knowledge to waiting and hoping for potentially another upward cycle of mining investment and R&D. Over the medium to longer term, the industry structure of the economy is not static and nor is Australia's R&D intensity.

The industry composition and cyclic factors view seems to imply that public policy has a somewhat limited role in influencing the level and trajectory of business R&D intensity. Yet the evidence suggests otherwise. Falk (2006) examines what drives business R&D intensity across OECD countries and finds that R&D tax incentives have a significant and positive influence on business R&D expenditure in OECD countries. An effective 1 per cent reduction in the 'cost' of business R&D (via a more generous tax incentive) leads to a 0.9 per cent increase in long-run business R&D expenditure. Furthermore, expenditures on R&D performed by universities are significantly positively related to business R&D expenditure suggesting the two are complements. While the evidence is less robust, direct R&D subsidies and specialisation in high-tech industries and patent rights also appear to be positively related to business R&D expenditure. In summary, governments can influence the level and trajectory of business R&D intensity.

Australia is not the only economy reliant on R&D from a small number of industries. The United States National Science Board (2022) points out that the US has a heavy concentration of R&D in a small number of industries. These industries are chemicals manufacturing; computer and electronic; products; transportation equipment; information services; and professional, scientific, and technical services. Yet despite this industry concentration in the US, it is a leading economy in terms of national R&D intensity.

When comparing Australia to other advanced economies, most if not all are dominated by relative growth in the services sector and the differences across these economies in their shares of manufacturing are becoming smaller, so that services industries R&D may become more

relevant to driving overall R&D intensity over time. Appendix A shows the relative rise of services industries such as professional, scientific and technical services and also finance and insurance, in business R&D expenditure in Australia. Potentially these services industries can fill the gap in R&D intensity in the face of a cyclical rise and decline (since around 2008–09) in mining sector R&D intensity.

The argument about industry sector mix and cycles of investment says little about what is the *optimal level* of R&D intensity for Australia.

Argument: Relative size of businesses in Australia explains our low national R&D intensity

Another industry composition argument is that Australia has a high proportion of small businesses in the economy and according to the Productivity Commission (2023a, p. 10): *"Some 98% of Australian businesses do not produce new-to-the-world innovations. They are adopters, adapters, incremental improvers".*

While it is true that smaller businesses contribute less in absolute R&D expenditure than larger businesses, Australian SMEs contribute a larger share of total business R&D expenditure in Australia than similar sized businesses in countries with much higher overall R&D intensities. Business size is an incomplete explanation of Australia's relatively low R&D intensity compared to other OECD economies.

The US for example, has a much higher national R&D intensity than Australia (an estimated 3.46 per cent of GDP, compared to Australia's 1.68 per cent of GDP). However, it has a similar proportion of small businesses to Australia. According to the United States Bureau of Labor Statistics (2024 a, b), businesses of employment size up to 19 people (including self-employed) make up 94 per cent of all businesses. According to the ABS (2024), in Australia around 97 per cent of businesses have an employment size of up to 19 people (including self-employed). So, there is very little difference in the relative distributions of businesses by

employment size between the United States and Australia, yet a marked difference in national R&D intensity.

Yet according to the United States National Science Board (2022), in the United States small businesses with up to 4 persons contribute only 0.5 per cent of total business R&D expenditure in the United States. This compares to Australia, where businesses of similar size contribute 8.6 per cent of total business R&D expenditure (Table 1). Similarly, businesses in the United States with 5–19 persons employed contribute 1.7 per cent of total business R&D, whereas in Australia businesses this size contribute 15.4 per cent of total business R&D expenditure. Registrations for the Australian Research and Development Tax Incentive (R&DTI) also confirm that Australian SMEs are active in core R&D activities.

The implication of the comparative data is that the argument that Australia has a high proportion of small businesses is not enough to explain our national R&D intensity performance.

Table 1: R&D expenditure by business employment size (per cent of total business R&D)

United States	2019	Australia	2021–22
Up to 4 persons	0.5	Up to 4 persons	8.6
5–19 persons	1.7	5–19 persons	15.4
20–249 persons	9.3	20–199 persons	31.3
250 or more persons	88.6	200 or more persons	44.7
Total	**100.0**	**Total**	**100.0**

Data sources: United States National Science Board (2022) and ABS data. Figures may not add due to rounding.

Argument: Prosperity is not dependent on growth in exports of "new-to-the world" products

Another argument discussed by the Productivity Commission (2023a) is that even if resources export prices fall, Australian prosperity is not dependent on growth in exports of "new-to-the world" products. This is because with a highly skilled workforce and other endowments, we will continue to benefit from a comparative advantage in tourism, education, and some professional and technology services.

It is true that Australia's prosperity relies not only on resources exports, and it certainly is to our advantage that we have a highly skilled workforce and other endowments. But the argument ignores the fact that the lack of R&D intensity results in potentially negative consequences for Australia's international trade competitiveness. Acquired R&D from overseas may come from industries in foreign countries that compete with the same industry in Australia, effectively meaning Australia would lag behind technologically in industries that compete with Australia internationally.

If we have less than optimal investment in R&D, we will likely also have a lower long term productivity growth rate, which will negatively impact our international competitiveness.

If we have less than optimal investment in R&D, we will likely also have a lower long term productivity growth rate, which will negatively impact our international competitiveness.

While services exports are an important source of growth, they also rely on new ideas or R&D. Also, education is our largest services export, and higher education is a significant contributor. But one factor making higher education in Australia attractive internationally is the internationally recognised research quality of our leading universities.

Argument: We do not need an "arbitrary" national R&D target

In an international review of the potential pitfalls of setting R&D intensity targets, a number of criticisms are discussed by Carvalho (2018). These criticisms and responses in the context of setting a national R&D intensity target in Australia include:

- **An R&D per cent of GDP target is arbitrary and there is no economic explanation or justification.** To the contrary, there are transparent analytical frameworks for measuring the societal return to R&D, which allows for a mapping to determine the degree to which actual R&D intensity differs to the societal optimal level of R&D intensity. One such framework is outlined in Jones and Williams (1998) and is applied to Australian data in the next section to estimate a societal optimal level of R&D that is above 3 per cent of GDP.
- **R&D is a means to an end, not an end in itself.** Yes, we recognise that an R&D intensity target is not an objective in itself, but R&D intensity is an important indicator of an economy's long-term innovation and productivity potential.
- **R&D only partially reflects innovation.** We also recognise that R&D is one factor in assessing Australia's innovation and productivity potential and other indicators (including those in the Australian Government's *Measuring What Matters Framework*) should continue to be measured and assessed.

Yes, we recognise that an R&D intensity target is not an objective in itself, but R&D intensity is an important indicator of an economy's long-term innovation and productivity potential.

- **R&D activities are increasingly taking place in an international context.** Yes, knowledge is global, and we recognise the international nature of R&D, including knowledge spillovers. But since an R&D intensity target captures expenditure in Australia, including that funded by sources of income from overseas (for example higher education R&D funded by incomes from international students or domestic business R&D funded by foreign capital), the measure is already reflective of the international nature of R&D activity and funding.
- **A target may require a sizeable shift in the balance of R&D expenditure between private and public sectors.** We are not proposing a target for Australian Government R&D spending that binds government spending or creates a sizeable shift between sectors. We are proposing a national target requiring private and public sectors to work together.
- **It is the efficiency and effectiveness of R&D expenditure that is equally if not more important.** We recognise that any R&D expenditure will continue to require prudent assessment of benefits and costs of individual investments. Nonetheless, at an economy-wide level there is evidence of the strong average private and public returns to R&D investment.
- **Does an R&D intensity target have real economic significance for a small open economy.** Economic growth in advanced economies is increasingly driven by innovation and productivity, underpinned by the creation and adoption of knowledge and investment in human capital. R&D expenditure is therefore an important ingredient and highly relevant.

3 Is Australia's R&D intensity optimal?

This section compares Australia's R&D intensity performance to the estimated long run "societal" optimal level of R&D intensity for Australia (societal in terms of economic, and environmental, cultural and social good).

As a nation, investing more in R&D comes at an opportunity cost of not investing in something else, however, the estimates suggest Australia is investing in R&D at a rate that is less than optimal, foregoing significant opportunities to enhance Australia's innovation and productivity capacity.

Australia's R&D intensity

Table 2 summarises Australia's R&D intensity performance. The overall decline in R&D intensity in Australia from its peak of 2.24 per cent of GDP in 2008–09 is 0.56 percentage points. This is driven predominantly by a decline in business R&D intensity and, to a smaller extent, a longer-term decline in government R&D intensity. The decline in business R&D as a per cent of GDP from 2008–09 to 2021–22 contributed 86 per cent (–0.48/–0.56) of the total decline in R&D intensity in Australia.

During the period from 2008–09, higher education R&D expenditure as a per cent of GDP has fluctuated – from 0.54 per cent of GDP in 2008–09 to 0.64 per cent of GDP in 2019–20 and then to 0.56 per cent of GDP in 2021–22.[7]

Appendix A provides further details on sectoral R&D expenditure over time.

7 The ABS has more recently published higher education R&D expenditure figures for calendar year 2022 of $13.99 billion, equating to 0.55 per cent of GDP in 2022.

Table 2: R&D intensity by sector in Australia (per cent of GDP)

Sector	R&D intensity in 2008–09 (peak for GERD)	R&D intensity in 2021–22	Percentage point change
Business	1.37	0.89	−0.48
Higher education*	0.54	0.56	0.02
Government	0.27	0.16	−0.11
Private not-for-profit	0.06	0.06	0
Total	**2.24**	**1.68**	**−0.56**

* See footnote 7. Data sources: ABS.

What is the optimal long-run R&D intensity for Australia?

Scepticism around whether Australia's relatively low R&D intensity and downward trend is an issue for innovation and productivity is based on observations that industry sector mix and cycles of mining investment may well help explain Australia's comparative low R&D intensity.

But this says nothing about the optimal level of R&D intensity for Australia and as noted previously, the societal (in terms of economic, and environmental, cultural and social good) net benefits of R&D are high, both globally and for R&D in Australia, reflective of R&D creating non-rivalrous and largely nonexcludable positive knowledge spillovers.

What is the optimal long-run R&D intensity for Australia and how does this compare to the trends in Australia's R&D intensity?

Jones and Williams (1998) set out an analytical framework for measuring the societal (marginal) return to R&D which allows for a mapping to determine the degree to which actual R&D intensity differs to the societal optimal level of R&D intensity. The framework is summarised in Appendix B. Estimates for Australia are summarised in Table 3.

The resulting estimate of the societal optimal level of R&D intensity is 3.67 per cent of GDP, higher than the 3 per cent of GDP R&D intensity aspiration adopted by the Australian Government.

The estimate of the societal optimal level of R&D to GDP in Australia is more than twice the current level of total R&D as a per cent of GDP (1.68 per cent) and equivalent to more than four times the current level of business R&D as a per cent of GDP highlighted in Table 3.

Table 3: Estimates of the societal optimal level of R&D intensity for Australia

Estimated societal optimal level of R&D intensity	Ratio of estimated societal optimal level of R&D intensity to actual total R&D intensity *	Ratio of estimated societal optimal level of R&D intensity to actual business R&D intensity **
3.67	2.18	4.12

* Estimated ratio using = 1.68 per cent of GDP for total R&D expenditure.
** Estimated ratio using = 0.89 per cent of GDP for business sector R&D expenditure.

Source: Go8 estimates using methodology in Jones & Williams (1998).

Should the decline in business R&D intensity reflect sub-optimal underinvestment by Australian businesses, it manifests over time in potentially less business innovation and productivity, which in turn implies that Australian businesses will be less competitive, globally and domestically, with productivity and real wages growth less than potentially achievable, and inflation higher than otherwise.

Should the decline in business R&D intensity reflect sub-optimal underinvestment by Australian businesses, it manifests over time in potentially less business innovation and productivity.

The discrepancy between this estimate of the societal optimal level of R&D intensity in Australia and the downward trend in R&D intensity for Australia over time is a worrying sign. It implies Australia's productivity and prosperity potential is not being maximised, and it lends credibility to a 3 per cent of GDP R&D target as a worthy ambition.

Other advanced economies are investing in their R&D intensities – for example, the UK Government has announced a *UK Research and Development Roadmap* that includes increasing overall UK investment in R&D. The United States has also recently increased its support for R&D, including through the CHIPS and Science Act (CHIPS – Creating Helpful Incentives to Produce Semiconductors).

The estimate of the societal optimal level of R&D intensity says nothing about over what period the shortfall between Australia's current R&D intensity and either the socially optimal level or the 3 per cent of GDP can be achieved, nor what mix of policy settings are needed to reduce the gap. We turn to these issues in the next sections, starting with projections of R&D intensity for Australia under different scenarios as a way of examining the feasible time horizon over which an R&D intensity of at least 3 per cent of GDP in Australia could be achieved.

4 Projections for Australia's R&D intensity

We have established that R&D expenditure, along with its widespread adoption and adaption, is an important source of improving Australia's innovative capacity. The societal returns to R&D in Australia are relatively high and the optimal level of R&D expenditure to GDP is estimated to be 3.67 per cent. This is higher than the 3 per cent of GDP R&D intensity aspiration adopted by the Australian Government and more than twice the estimated current level of total R&D as a per cent of GDP of 1.68 per cent.

Whilst the Australian Government has an aspiration for R&D expenditure reaching 3 per cent of GDP, it has not specified a timeline or plan for how this will be achieved. This section provides projections of R&D intensity for Australia under different scenarios as a way of examining the feasible time horizon over which R&D intensity of 3 per cent of GDP in Australia could be achieved.

... an R&D intensity target of 3 per cent of GDP can be achieved over a horizon of approximately 10 years (by 2035–36) if we can augment average long-term historical growth in R&D for Australia.

The projections suggest an R&D intensity target of 3 per cent of GDP **can be achieved over a horizon of approximately 10 years (by 2035–36)** if we can augment average long-term historical growth in R&D for Australia. However, this requires immediate policy action and by failing to make optimal investment in R&D today, the negative impacts on innovation capacity and productivity will be experienced many years into the future.

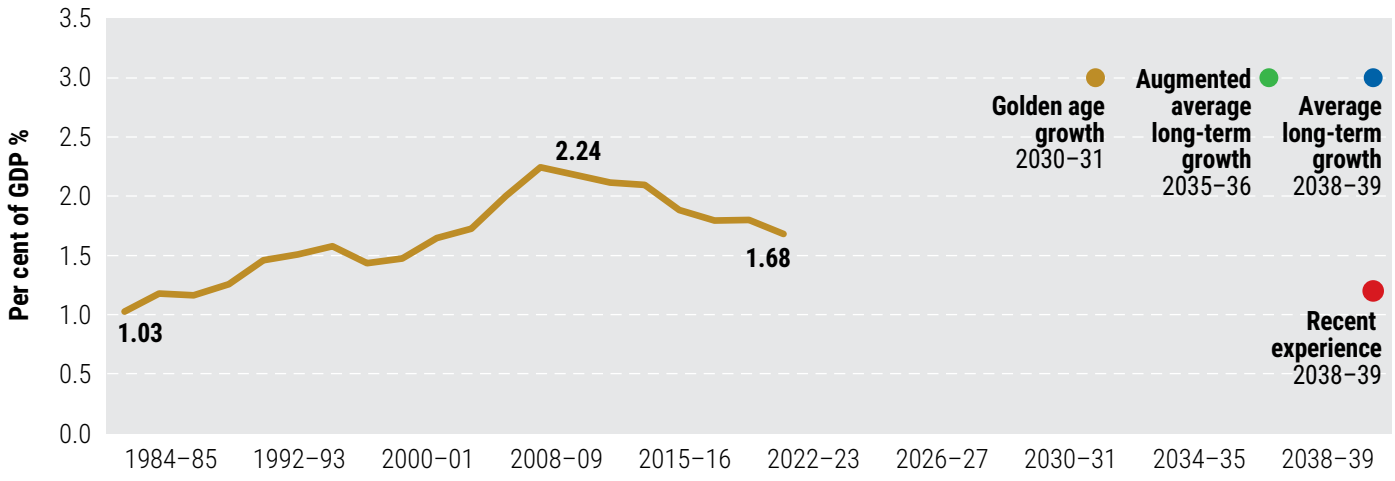
We use the historical experience of R&D expenditure across the four sectors (business, higher education, government and not for profits) in Australia as a way of identifying national R&D intensity trajectories.

Since we are considering the trajectory of R&D expenditure as a per cent of (nominal) GDP, the denominator for the trajectory is taken to be the annual nominal GDP growth rates from the latest *Intergenerational Report 2023* ("IGR 2023") applied to the ABS published nominal GDP level for 2021–22. For years within each scenario where there is growth in R&D expenditure, an additional "GDP dividend" augments the nominal GDP growth rate assumed in the IGR 2023 using an output elasticity of R&D expenditure of 0.15, which is a consensus figure from a review of the literature by the OECD (2015). For the numerator, the "base year" is the ABS estimated level of R&D expenditure (in nominal dollars) in each sector in 2021–22.

Four illustrative scenarios for R&D intensity in Australia are considered with the resulting projections presented in Chart 5. Details of the assumed annual sectoral growth rates in R&D expenditure are provided in Appendix C:

- **Recent experience** (given by the red point): Under this scenario, each sector's annual R&D expenditure annual growth rate is its average annual growth rate from 2008–09 (i.e., reflecting the historical downward trajectory in R&D intensity since 2008–09 given in Chart 5).
- **Golden age growth** (given by the gold point): Under this scenario, each sector's annual R&D expenditure annual growth rate is its average annual growth rate from 1984–85 to 2008–09 (i.e., reflecting the historical upward trajectory in R&D intensity over this period given in Chart 5).
- **Average long-term growth** (given by the blue point): Under this scenario, each sector's annual R&D expenditure growth rate is its average annual growth rate since 1984–85 (reflecting long-term growth using earliest data available).

Chart 5: Projections of R&D intensity in Australia in each scenario



Source: Go8 projections using ABS data.

- **Augmented average long-term growth** (given by the green point): This is a variant of the third scenario, where each sector's R&D expenditure grows annually by 1 percentage point above its average annual rate since 1984–85.

Starting with the scenario of achieving only recent growth (annual growth since the peak of R&D intensity in 2008–09) in R&D expenditure in each of the four sectors means that Australia will not foreseeably reach a 3 per cent of GDP R&D intensity target. This is the red point in Chart 5 and implies that by 2038–39, for example, Australia's R&D intensity would be at 1.2 per cent of GDP, marginally higher than it was in 1984–85. This is obviously not a recipe to reap the social benefits of R&D and innovation leading to productivity and would potentially render Australia's economy less dynamic and unable to meet the challenges and opportunities posed in the recent IGR 2023.

In contrast, a highly optimistic scenario is the golden age growth scenario given by the gold point in Chart 5. This scenario shows the trajectory for national R&D intensity if we achieve the sustained average annual growth rates in R&D by sector that we saw from 1984–85 to 2008–09. This scenario implies we reach a 3 per cent of GDP R&D intensity target in less than a decade, spurring Australia closer to the estimated optimal rate of R&D intensity (3.67 per cent) and we reap the benefits of R&D-led higher innovation and productivity as we move closer to the global technological frontier.

Two intermediate scenarios are given by the blue and green points in Chart 5. The scenario given by the blue point takes the long-term average annual growth rate (over the entire period since 1984–85), and applies that average annual rate into the future. It shows that we would achieve an R&D intensity target of 3 per cent of GDP in around 15 years (by around 2038–39). As a nation, the unanswered questions are whether we are prepared to follow such a protracted steady path and will that be sufficient to assist us meet the challenges and opportunities posed in the recent IGR 2023.

It shows that 1 percentage point higher annual growth can result in Australia achieving an R&D intensity of 3 per cent of GDP approximately 3 years earlier (by around 2035–36) and with 3 additional years of benefits associated with R&D leading to innovation and productivity.

The scenario given by the green point is a minor variation – adding 1 percentage point to the long-term average annual growth for each sector relative to the average long term growth scenario. It shows that 1 percentage point higher annual growth can result in Australia achieving an R&D intensity of 3 per cent of GDP approximately 3 years earlier (by around 2035–36) and with 3 additional years of benefits associated with R&D leading to innovation and productivity. This "augmented average long-term growth" scenario is an ambitious but achievable scenario with the right policy reforms discussed in the next section.

All of the scenarios lead to one conclusion – for Australia to improve its R&D intensity to 3 per cent of GDP will require a substantial improvement on post 2008–09 performance. In particular, it will require an uplift in business R&D intensity in Australia, given it contributes over half of all R&D expenditure in Australia, and given the decline in business R&D as a per cent of GDP from 2008–09 to 2021–22 contributed 86 per cent of the total decline in R&D intensity.

The projections suggest reaching a R&D intensity target of 3 per cent of GDP over a horizon of approximately 10 years is ambitious yet achievable if we can augment average long-term historical growth in R&D for Australia. The next section considers candidate policies to create this improvement in R&D intensity and innovation in Australia.

The projections suggest reaching a R&D intensity target of 3 per cent of GDP over a horizon of approximately 10 years is ambitious yet achievable if we can augment average long-term historical growth in R&D for Australia.

5 Policies to enhance R&D intensity and innovation

This section considers policy reform directions to enhance R&D intensity and innovation in Australia. It is not intended to be a comprehensive discussion of Australia's innovation system nor a detailed analysis of the efficacy of individual policy measures.

The Productivity Commission (2023a) produced a nine-volume review of productivity in Australia, and a comprehensive review of the R&D Tax Incentive (R&DTI) was conducted in 2016 (Ferris, Finkel & Fraser, 2016) with subsequent reforms announced in the 2020–21 Budget.

This section serves as a high-level discussion starter in the development of the proposed Roadmap to achieve an R&D intensity of 3 per cent of GDP.

The framework for the policy discussion to a large extent follows an **"innovation policy toolkit"** approach developed by Bloom, Van Reenen & Williams (2019), who discuss how advanced economies can revive their productivity performance through innovation by identifying and assessing the evidence on the effectiveness of various candidate innovation related policies.

The policies within the toolkit assessed by Bloom et al. (2019) are listed in Table 4. Their assessment is focussed heavily on evidence for the United States although they do consider some international evidence, which is relevant to the Australian context.

The innovation policy toolkit in the context of Australia

R&D Tax Credits

In the United States context this refers mainly to R&D tax credits for businesses. In their assessment, Bloom et al. (2019) score R&D tax credits for businesses as three out of a maximum possible three on net benefits and suggest the benefits are likely to be seen in the short run (roughly in three to four years).

Table 4: Innovation policy toolkit

Policy area	Authors' net benefit assessment (maximum rating is 3)
R&D tax credits	3
Trade and competition	3
Skilled immigration	3
Universities: STEM supply	2
R&D grants, including targeting small firms	2
Universities: incentives	1
Mission-oriented policies	1
Intellectual property reform	Unknown *
Patent box	Negative

Source: Bloom, Van Reenen & Williams (2019). * The authors are not claiming intellectual property reform is not important, the rating reflects they only considered two specific areas: what types of technologies should be patent eligible; and litigation by patent owners who themselves are not active in creating new patents. For both areas they suggest there is inconclusive evidence on appropriate policy reforms.

The authors suggest, based on a review of the empirical research that a 10 per cent decline in the tax price of R&D results in at least a 10 per cent increase in R&D in the long run (an elasticity of 1 or greater).

The design and application of business R&D tax incentives is crucial – they need to provide the basis for "additionality" – additional R&D that would not have been otherwise undertaken.

Section 5: Policies to enhance R&D intensity and innovation

The R&D tax incentives cannot be merely a vehicle for relabelling other expenses as R&D to receive a tax break without any meaningful contribution to innovation and productivity (Chen et al., 2021). Further, R&D tax incentives should not create distortions to the dynamism of the economy, such as propping up less innovative businesses instead of them exiting operations (Acemoglu, et al., 2018).

Business R&D tax incentives may also be more relevant for medium to large businesses that already do R&D, whereas Australia has a relatively high concentration of smaller businesses and for smaller firms significant investments in R&D may be too costly (Productivity Commission, 2023b). **Therefore R&D tax incentives may cater for some businesses, but not be a substitute for a grants type program discussed later, focussed on smaller businesses doing research.**

In the Australian context, the Research and Development Tax Incentive (R&DTI) is the key program with the Government providing an estimated $3.2 billion through the R&DTI in 2022–23.[8]

Information in the Mid-Year Economic and Fiscal Outlook 2023–24 indicates that the Australian Treasury expects payments from the R&DTI to further increase by $2.1 billion over four years to 2026–27, especially for the professional, scientific and technical services industry.

To claim the tax incentive, an eligible business must have total R&D spend for the income year of at least AU$20,000. Under the R&DTI there is a research service provider arrangement whereby businesses can engage universities to perform research and development on their behalf although the extent to which this has incentivised additional collaboration between business and university sectors is not entirely clear.

8 Source: Australian Government Science, Research and Innovation Budget Tables, 2022–23.

The R&DTI was reviewed in 2016 (Ferris, Finkel & Fraser, 2016), and more recently in the 2020–21 Budget, there were a raft of changes made, including for example, the R&D expenditure threshold being increased to $150 million from $100 million, and R&D entities with aggregated turnover of less than $20 million being entitled to an R&D tax offset rate equal to their corporate tax rate plus an 18.5 per cent premium.

One area of the 2016 R&DTI Review that has not directly been implemented was a recommendation to introduce a collaboration premium (up to 20 per cent for the non-refundable tax offset) to provide additional support for the collaborative element of R&D expenditure undertaken with publicly funded research organisations. This recommendation was echoed by Innovation and Science Australia (2017).

Under the Ferris, Finkel & Fraser (2016) Review recommendation, the premium would also apply to the cost of employing new PhD or equivalent graduates in STEM in their first three years of employment.

The Go8 supports this reform direction. The introduction of such measures would complement the Industry PhD and Fellowship program by providing demand-side incentives for firms to engage with universities in higher degree by research (HDR) training, and the recruitment of graduate researchers.

The Business Council of Australia (2023) in its response to the Universities Accord Interim Report suggested reviewing existing incentives such as the R&DTI, including consideration a collaboration premium for businesses engaged with universities. The Institute of Public Accountants – Deakin University SME Research Centre has also called the R&DTI to focus explicitly on incentivising research collaboration through introducing a 20 per cent premium on relief provided by the R&DTI for collaboration by business with research institutions (Tanewski et al., 2021).

Section 5: Policies to enhance R&D intensity and innovation

Trade and competition

Trade openness provides a competitive pressure and according to Bloom et al., can also contribute to innovation, by increasing market size and therefore spreading the cost of innovation over a larger market, and/or leading to faster knowledge diffusion. Competition may encourage innovation such as forcing businesses to innovate to stay competitive. In their assessment, Bloom et al. (2019) score trade and competition as three out of a maximum possible three on net benefits and suggest the benefits are likely to be seen in the medium term (around five to ten years).

Competition may encourage innovation such as forcing businesses to innovate to stay competitive.

The importance of trade openness and competition has long been recognised in Australia. Trade liberalisation and reduced industry protection since the 1970s have resulted in a more dynamic, and prosperous Australian economy (Centre for International Economics, 2017), including through access to innovation embedded in new technologies developed overseas. Competition policy reforms have also been enacted, including the National Competition Policy (NCP) in the late 1990s and early 2000s.

The Productivity Commission (2023a) made a number of recommendations to reform trade in the context of boosting economic "resilience", including reducing Australia's statutory import tariff levels to zero and reducing non-tariff barriers to trade in services. In March 2024, the Treasurer announced that the Australian Government will abolish almost 500 different tariffs, to reduce business compliance costs and red tape (Chalmers, 2024).

International trade is not a given and requires ongoing effort. We recently saw a proposal to tax Australia's higher education services exports through a levy on higher education international student income that would cause adverse economic

impacts to Australian education export volumes (our leading services export) and the Australian economy more generally. This damage would be at a time when we are trying to revive export markets and growth.

Another way Australia benefits from trade is through international collaboration and research partnerships. Increasingly, research is undertaken through global research partnerships to take advantage of scale (e.g., gravity wave detection access to infrastructure like CERN, and global participation such as the Square Kilometre Array), access to large scale infrastructure, as well as funding source opportunities internationally, particularly in science where scale is important. **Australia needs to be at the forefront of this engagement. Supporting stronger global partnerships through research collaboration offers large potential for improved domestic R&D and productivity.**

On competition reforms, the Treasurer has recently announced a 2-year *Competition Review* given productivity growth has slowed and cost of living has increased. The Review has a broad remit including examining competition law and policies so that they remain relevant. In addition, the Review will examine mergers reform; competition law issues through the Australian Competition and Consumer Commission (ACCC); options for coordinated reform with States and Territories; and competition challenges raised by new technologies, the net zero transformation agenda, and growth in the care economy (Chalmers, 2023a).

Increasingly, research is undertaken through global research partnerships to take advantage of scale, access to large scale infrastructure, as well as funding source opportunities internationally, particularly in science where scale is important.

Section 5: Policies to enhance R&D intensity and innovation

Skilled immigration

Skilled immigration is a supply-side measure to increase the availability of skilled human capital to conduct innovative activities. In their assessment, Bloom et al. (2019) score skilled immigration as three out of a maximum possible three on net benefits and suggest the benefits are likely to be seen in the short to medium term (from around three to ten years).

The Review of the Migration System Final Report *highlights the essential role of skilled migration to Australia in bringing human capital and experience that would otherwise take time to develop domestically, with evidence suggesting skilled migrants have had a positive impact on Australian productivity and the wages of domestic higher skilled workers.*

The *Review of the Migration System Final Report* (Australian Government Department of Home Affairs, 2023a) highlights the essential role of skilled migration to Australia in bringing human capital and experience that would otherwise take time to develop domestically, with evidence suggesting skilled migrants have had a positive impact on Australian productivity and the wages of domestic higher skilled workers. **The Migration Review also recognises the importance of international student transitions into the Australian workforce. Australia with its high-quality education institutions and research capacity, is an attractive destination for international students, with the Go8 universities having an international student cohort of over 150,000 students, with one in three of Australia's international students choosing to study at a Go8 university.**

In response to the Review, the Australian Government's recently announced Migration Strategy is introducing a new *Skills in Demand* visa with clear pathways to permanent residency, including a "specialist skills pathway" to attract highly skilled workers in sectors such as technology and "green" energy industries (Australian Government Department of Home Affairs, 2023b). There is merit in international students obtaining a PhD at an Australian university receiving direct and expedited permanent residency under this new visa.

Beyond providing a permanent residency pathway for international students obtaining a PhD at an Australian university, Australia needs to attract and retain high-quality international researchers to augment Australia's existing domestic research workforce. This is particularly relevant in having a highly skilled science, technology, engineering, and mathematics (STEM) workforce, further discussed below. **If the Migration Strategy is to achieve its goal of reshaping Australia's permanent skilled migration system, it is imperative that the Australian Government pursue the implementation of the proposed new Talent and Innovation visa. This includes specific provisions for the attraction and retention of experienced high-quality international researchers**.

Universities: STEM supply

According to Bloom et al., this is a supply-side measure in which the quantity of innovation activity can be increased by increasing the availability of skilled human capital that undertake research activity, as well as boosting R&D indirectly by reducing the equilibrium price of R&D workers. In their assessment, Bloom et al. (2019) score STEM supply through universities as two out of a maximum possible three on net benefits and suggest the benefits are likely to be seen in the long-term (approximately ten years or more).

The importance of STEM skills in the workforce has been recognised in Australia with various previous and current initiatives to raise workplace skills in STEM. For example, the

National STEM School Education Strategy 2016-2026 was agreed through the Council of Australian Governments Education Council. More recently, the Women in STEM Cadetships and Advanced Apprenticeships Program aims to increase access to, and participation of, women in a STEM field. The National Priorities and Industry Linkage Fund (NPILF), which is in pilot stage, allocates grants to universities to increase the number of internships and work-integrated learning; increase the number of STEM-skilled graduates; and develop partnerships with industry. Also, starting in 2024 an additional 4,001 Commonwealth supported places in STEM courses will be funded by the Australian Government to assist in delivering the AUKUS nuclear-powered submarine project.

Science and Technology Australia (2023), identifies how barriers to STEM careers could be addressed, including improved coordination between tertiary education sectors; improved access to work-based placements and other training and upskilling; and improved utilisation of skilled migrants and international graduates.

Jobs and Skills Australia (JSA) analysis for its annual Jobs and Skills Report suggests current skills needs are also concentrated around occupations in the services sector, related to health care, ICT and science, technology, engineering, and STEM-related occupations.

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A key area of reform to boost STEM supply through universities relates to the discipline funding rates. The Australian Universities Accord Review Panel (2023) has highlighted that the *Job-ready Graduates* (JRG) funding rates have negatively impacted the capability of the higher education sector to deliver high-quality education in the STEM disciplines. A new model for funding university education in STEM is needed that addresses necessary recurrent per student funding, research costs, and infrastructure and equipment costs.

Bloom et al. (2019) highlight that the amount of R&D and innovation activity that can be done is a function of the research workforce. Separate from the Universities Accord, Australia needs a workforce of researchers to do the "R" in R&D if Australia is to lift its R&D intensity towards 3 per cent of GDP.

We need to grow the domestic research workforce and augment it with skilled migration of world leading researchers. For example, investment in the human capital of our research workforce should include ensuring stipends and scholarships for higher degree by research (HDR) students are attractive to retain and grow the pool of researchers in Australia.

The importance of increasing the supply of STEM graduates through universities does not come at the expense of recognising the importance of investing in education during earlier stages of life, or the contribution of other fields of study such as humanities, or the importance of vocational education and training. For example, access to quality education, including in STEM, for low socioeconomic students earlier in life can form the basis for their interest in, and demand, to become STEM professionals later in life. Primary and secondary education programs in STEM are important, as is mentoring and role models. These themes are highlighted in the Australian Universities Accord Review Panel Final Report (2024).

Australia needs a workforce of researchers to do the "R" in R&D if Australia is to lift its R&D intensity towards 3 per cent of GDP.

Section 5: Policies to enhance R&D intensity and innovation

R&D grants, including targeting small firms

This policy area includes R&D grants to universities (and other not for profits, such as public research institutes), as well as from government to (smaller or younger) businesses.

In their assessment, Bloom et al. (2019) score these policies as two out of a maximum possible three on net benefits and suggest the benefits are likely to be seen in the medium term (approximately five to ten years). Their favourable assessment is underpinned partly by, on balance, evidence of public research and development grants "crowding-in" additional innovation activity.

Small business programs

In the United States context, this includes *America's Seed Fund* that incorporates both the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) competitive grant programs, aimed at commercialisation of R&D by smaller firms. The United States' Fund is coordinated by the Small Business Administration and funded through 11 federal agencies that fund innovations through the SBIR/STTR programs. Around US$ 4 billion is invested each year.

The SBIR program has been in place in the United States since 1982. The STTR program, which has been in place from 1992, is intended to facilitate technology transfer from research institutions to small business. Under these programs, US federal government agencies, subject to thresholds, are required to set a per cent of their extramural R&D budgets to fund small businesses (United States Small Business Administration, 2020). According to the US Small Business Administration, which is the coordinating agency for the programs, the key differences of the STTR program relative to the SBIR are:

- Requirement for the small business to partner with a research institution and have an associated IP agreement in place.
- The small business must perform at least 40 per cent of the R&D and a single partnering research institution at least 30 per cent.
- Allowing the principal researcher to be primarily employed by the partnering research institution.

There is an existing suite of Australian programs (at the federal and state levels) similar to the United States SBIR program focussed on various aspects of small to medium enterprises (SMEs) and startup innovation and growth. For example, the Industry Growth Program aims to encourage SMEs and startups to commercialise and grow within the National Reconstruction Fund (NRF) priority areas. Also, the Business Research and Innovation Initiative (BRII), modelled on the United States SBIR program, provides grants for innovative solutions to government policy and service delivery challenges, where Australian Government agencies support the program to develop new-to-market technologies that they can negotiate to buy. The New South Wales (NSW) Government has a SBIR type program where NSW based SMEs apply for competitive grants with proposed solutions to government agency stated challenges.

To further incentivise R&D activity by small businesses, there is merit in a national STTR program in Australia. Given limited resources, some SMEs may focus on local markets and immediate business opportunities and challenges, so a national STTR equivalent program needs to be straightforward to access. A nationally focussed STTR program can also help to broaden the horizon of SMEs beyond the immediate term and enable SMEs to tap into nationwide expertise at Australian universities that would not otherwise be utilised.

Given limited resources, some SMEs may focus on local markets and immediate business opportunities and challenges, so a national STTR equivalent program needs to be straightforward to access.

Access to (private) finance

Bloom et al. (2019) also suggest removing constraints in early-stage finance markets is worth considering,

and using subsidised loans for younger firms rather than general tax breaks or grants (because of the potential disincentive to grow if subsidies are withdrawn beyond a firm size threshold).

In Australia, the ABS (2022) suggests that 20 per cent of businesses during the two years ended June 2021 had a "lack of access to additional funds" as a barrier to innovation in relation to financial constraints faced by businesses.

Both access and cost of finance for smaller firms has been previously identified (Productivity Commission, 2023b). In Australia, the ABS (2022) suggests that 20 per cent of businesses during the two years ended June 2021 had a "lack of access to additional funds" as a barrier to innovation in relation to financial constraints faced by businesses.

There are a range of existing support programs at the federal and state/territory levels of government for access to finance. One example is the Australian Government Biomedical Translation Fund (BTF), which is an equity co-investment venture capital program targeting early-stage biomedical companies. The usefulness of this type of program for firms in other sectors could be examined.

The Australian Government has had programs designed to stimulate early-stage venture capital, such as the Early Stage Venture Capital Limited Partnerships (ESVCLP) program and the previously associated pooled development funds (closed to new applicants) that aimed at raising capital for small and medium sized businesses. Also, the Australian Venture Capital Fund of Funds (AFOF) program encourages investment in ESVCLPs and venture capital limited partnerships (VCLPs). In addition, some universities have established their own investment funds to help early-stage startups.

For example, the $15 million University of Melbourne Genesis Pre-Seed Fund and Monash University's $15 million Pre-Seed Fund (with part funding from Breakthrough Victoria, under the Victorian Government's $2 billion Breakthrough Victoria Fund).

More broadly, some superannuation funds have focussed on "impact" investing – targeted investments focussed on social and/or environmental improvement impacts. This has extended, for example, to seed funding for early-stage commercialisation opportunities from university and other research. However, while impact investing has grown, there are potentially constraints through Australia's regulatory system to superannuation fund investments of this type. For example, both the sole purpose test and best financial interests duty may pose a limiting factor in (pre) seed early-stage investments. The Australian Government could review superannuation regulatory settings to enhance the opportunity for superannuation funds to choose early-stage seed investments within their mandates and duties to members.

Absorptive capacity of businesses

In the Australian context, the Productivity Commission (2023b) has highlighted that most Australian businesses, particularly SMEs, do not operate at the technology frontier and emphasis should be on the diffusion of existing knowledge that is, businesses having the absorptive capacity to adopt and adapt existing knowledge. Absorptive capacity is correlated with the ability of organisations to generate ideas internally, and this is in turn influenced by a number of factors that include the organisation's R&D expenditure and intellectual resources of professional specialist employees (de Rassenfosse & Webster, 2016).

Limited absorptive capacity within SMEs is considered a barrier to collaboration between SMEs and Australian universities and research institutes, with barriers to initiating collaboration including lack of information; financial costs; and differences in objectives, culture, and ways of operation between businesses and research institutions (Verreynne et al., 2021). Other

barriers to SMEs collaborating with research institutions include lack of time and insufficient funding (Tanewski et al., 2021) and limited management capabilities to engage in new to market innovations (Industry Innovation and Science Australia, 2023). More broadly there are challenges in navigating, applying for, and winning access to government grant programs.

Business linkages with research institutions

The Productivity Commission has emphasised that business linkages with universities can also build absorptive capacity across firms and acknowledges recent efforts, such as through the University Research Commercialisation Action Plan, but suggests that, by focusing on direct commercialisation activities and advanced manufacturing industries, these are too narrow in scope.

Associated barriers to collaboration by businesses with the research sector have attempted to be addressed through various government initiatives. Some initiatives include:

- Cooperative Research Centres (CRCs). This program funds industry-led collaborations with researchers, and while not specifically targeted to SMEs, the project-based CRCs (CRC-Ps) for smaller projects can potentially be worthwhile avenues of R&D support for SMEs. The Institute of Public Accountants – Deakin University SME Research Centre has called for expanded investment in CRC-Ps as a means to address collaboration issues of SMEs (Tanewski et al., 2021). The Australian Government in February 2024 announced funding for 21 new CRC-Ps as part of the CRCs program (Cooperative Research Australia, 2024), with the Minister for Industry and Science stating that the CRC-Ps initiative has so far committed $553 million (Husic, 2024).
- The Australian Research Council (ARC) Linkage Program, while not specifically targeted to SMEs, aims to facilitate partnerships between researchers and businesses, as well as community organisations and other publicly funded research agencies. For example, under the

ARC Linkage Program, there are *Early Career Industry Fellowships* and *Mid-Career Industry Fellowships* that attempt to foster two-way mobility and skill-building between industry and academic based researchers. Mobility of researchers between research institutions and industry is an important way to transfer knowledge between organisations (Thomson & Webster, 2024).

- The CSIRO *Innovate to Grow* program, designed for SMEs, but so far limited to high-priority sectors, assists to develop actionable business and R&D funding plans.

Australia is not the only economy that has attempted to boost R&D collaboration between businesses and the higher education sector. In the United Kingdom (UK) there has been in place a Higher Education Innovation Fund for close to twenty years. This UK Fund supports activities by higher education institutions that increase their capability to respond to the needs of business through collaborations that lead to identifiable economic benefits (Higher Education Funding Council for England, 2006).

This has included supporting university spin-out companies.

Access to, and utilisation of research infrastructure, including through collaborative arrangements between industry, government and research institutions, is important if Australia is to lift its R&D intensity. The National Collaborative Research Infrastructure Strategy (NCRIS) program under the Australian Government Department of Education manages Australia's national research infrastructure.

The Productivity Commission has emphasised that business linkages with universities can also build absorptive capacity across firms and acknowledges recent efforts … but suggests that, by focusing on direct commercialisation activities and advanced manufacturing industries, these are too narrow in scope.

Section 5: Policies to enhance R&D intensity and innovation

Successive Australian Governments have invested funds to support access to national research infrastructure through 5-yearly roadmaps and annual funding rounds. It is important that the long-term funding for NCRIS is supported, and that its utilisation for collaboration between industry and the research sector is maximised.

The framework includes encouraging staff and students to undertake research in partnership with industry, government and community groups to deliver social, economic and industry impact.

In terms of differences in objectives, culture, and ways of operation between businesses and research institutions as barriers to collaboration, the Go8 universities have developed a collaboration framework to help facilitate industry-research partnerships. The framework includes encouraging staff and students to undertake research in partnership with industry, government and community groups to deliver social, economic and industry impact. The framework also encourages knowledge exchange with industry, government and community groups and emphasises that all partnerships and associated commercial agreements will be developed and negotiated in a professional and responsive manner. Issues regarding commercial agreements between universities and businesses, including intellectual property, are discussed further in this section.

The Productivity Commission suggests another part of the answer to improving business linkages with universities is enabling more consulting to business by academics. While consulting activities linked to university research can be approved by university management under certain circumstances, and these may be an avenue for new collaborations, longer-term there needs to be more "partnerships" between universities and business on basic research in particular, rather than discrete consultancies which may have little new fundamental research content.

Co-location of businesses and research organisations

Bloom et al. (2019) suggest that despite the popularity of policies to co-locate smaller higher tech firms together, the evidence remains somewhat ambiguous. They are more optimistic about the co-location of "science-based" universities and businesses focussed on innovation; an approach taken up in Australia through various "precincts" such as the Monash University precinct in south-east Melbourne.

There is Australian evidence in support of these initiatives – for example Bakhtiari & Breunig (2017) find positive effects on Australian R&D expenditure from spillovers from peers and clients to firms within 25 or 50 kilometres, with R&D expenditure by academia within the same jurisdiction having a positive influence on a firm's own R&D expenditure.

The former Australian Government Department of Industry, Innovation and Science (2018) published a *Statement of Principles for Australian Innovation Precincts*. These include principles of local leadership; removing barriers and aligning policy; building capability and connections; and skills development. One of the key elements is for governments at all levels to ensure alignment of policies and activities to promote collaboration. For example, place-based funding initiatives should aim to align with national science priorities and strategies. Achieving this type of alignment and collaboration may require further coordination through, for example, National Cabinet and between state and local governments, particularly in relation to physical research infrastructure.

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Universities: incentives

Universities incentives refers to ownership rights for universities and academics in the intellectual property developed at their institutions, as an incentive to commercialise research. In their assessment, Bloom et al. (2019) score universities incentives one out of a maximum possible three on net benefits and suggest the benefits are likely to be seen in the medium term (around five to ten years). This does not mean incentives do not matter or do not have an impact. The relatively low score is primarily a function of a lack of conclusiveness of existing evidence to draw policy conclusions.

Among the Go8 universities, five of the eight have a formal policy which prescribes apportioning net commercialisation proceeds equally between the creator(s), the creators' faculty, and to the central university division.

According to the Australian Law Reform Commission (2010) "universities may claim ownership of inventions created: using university resources; by academic staff in the course of their employment; and through publicly funded research received as part of an agreement with a government funding agency". Universities in turn may have formal intellectual property policies and individual contractual arrangements with their academic staff and third parties (such as businesses). Some universities also have business start-up and transfer organisations.

In regard to their academic staff, university arrangements can include for the sharing of commercialisation revenue. For example, among the Go8 universities, five of the eight have a formal policy which prescribes apportioning net commercialisation proceeds equally between the creator(s), the creators' faculty, and to the central university division. It should be noted that this model is in place at the University of Queensland and, as the leading university in Australia for net commercialisation revenue and for equity held in

start-ups, this model of sharing commercialisation revenue has not been a disincentive to research being translated to commercial ventures.

In regard to intellectual property between universities and third parties (such as businesses), the Australian Government Department of Education (2022) has published a voluntary *Higher Education Research Commercialisation Intellectual Property Framework*.

This includes developing and providing various IP related agreement templates for businesses and universities to use in their negotiations. Given the infancy of the Framework, it is not clear how well known and utilised it is by businesses, and how well it serves the purpose of facilitating businesses to work with universities on research and commercial projects.

From a Go8 universities perspective, the IP related agreement templates developed have only provided limited utility, primarily because these universities have sophisticated agreements and processes in place.

Consultation with Go8 universities suggests there needs to be improvements made to the template agreements provisions to address inappropriate liability provisions and unreasonable intellectual property indemnities for universities as public institutions.

In regard to intellectual property between universities and third parties (such as businesses), the Australian Government Department of Education (2022) has published a voluntary Higher Education Research Commercialisation Intellectual Property Framework.

It is important that these template agreements continue to remain voluntary, allowing for entities to have the flexibility of using individualised agreements that are bespoke to their circumstances. The Australian Government Department of Education intends to test, review, and identify best practice use of the Framework in 2024.

Section 5: Policies to enhance R&D intensity and innovation

Mission-oriented policies

Examples of mission-oriented policies include R&D policies and other programs that focus support on particular technologies or sectors, such as space, defence, climate change and disease reduction.

Positioning Australia to transition to net zero greenhouse gas emissions by 2050 and making Australia a renewable energy "superpower" is one mission that is driving Australia's industry policy agenda.

In their assessment, Bloom et al. (2019) score mission-oriented policies one out of a maximum possible three on net benefits and suggest the benefits are likely to be seen in the medium term (around five to ten years). Their low rating of mission-oriented policies is based on both relatively low quality and inconclusiveness of evidence.

Positioning Australia to transition to net zero greenhouse gas emissions by 2050 and making Australia a renewable energy "superpower" is one mission that is driving Australia's industry policy agenda (Albanese, 2024). Other Australian national missions include national sovereignty, with associated AUKUS commitments, and also diversifying and transforming Australian industry as part of a mission to drive sustainable economic growth.

The success of these missions will depend not only on significant investment in new technologies, but also on the R&D to create and apply those technologies to Australia, and the presence of a large enough quality research workforce in Australia. R&D may be embodied in technologies developed overseas, but there will need to be domestic R&D capacity to be able to adopt and adapt R&D developed overseas.

One of the most significant recent government initiatives in support of research has been the creation of the Medical Research Future Fund (MRFF). The MRFF has reached its full

capitalisation target of $20 billion and the earnings from this fund are used to fund $650 million in translational health and medical research annually. Research funded under the MRFF directly targets health outcomes for the Australian community.

New and emerging technologies such as artificial intelligence, and quantum science and technologies, often require infrastructure such as specialised, often expensive, computing power. For example, estimates suggest two-thirds of the global market for cloud computing resources used to train and develop AI models is controlled by Microsoft, Google and Amazon (Sanders et al., 2024).

Intellectual property reform

This area involves broader intellectual property policies beyond universities. It is about the appropriate balance between providing intellectual property rights (such as through patents and copyrights) to inventors and opening those inventions to others much earlier (knowledge diffusion).

In their assessment, Bloom et al. (2019) score intellectual property reform as "unknown" on net benefits and suggest that any net effect is likely to be seen in the medium term (around five to ten years). Again, this is not to understate the importance of well-functioning and efficient intellectual property systems, the low score reflects that Bloom et al. only considered two specific areas: what types of technologies should be patent eligible; and litigation by patent owners who themselves are not active in creating new patents.

The Medical Research Future Fund (MRFF) has reached its full capitalisation target of $20 billion and the earnings from this fund are used to fund $650 million in translational health and medical research annually.

For both areas they suggest there is inconclusive evidence on appropriate policy reforms.

In the Australian context, the Productivity Commission (2023b) in its emphasis on supporting the diffusion of best practice and knowledge that has already been generated suggests reforms to require open access to research principally funded by governments. For example, the Productivity Commission (2023b) indicate that in the United States publicly funded medical research is made freely available, and there are several models to consider how such reforms could be implemented.

In their assessment, Bloom et al. (2019) score a patent box as creating negative net benefits because it is in their view a harmful form of tax competition, with little positive impact on the quantity of R&D or innovation.

Patent box

A patent box is essentially a tax concession for specified income derived from certain forms of intellectual property activity. In their assessment, Bloom et al. (2019) score a patent box as creating negative net benefits because it is in their view a harmful form of tax competition, with little positive impact on the quantity of R&D or innovation.

In the Australian context, the previous Australian Government announced in the 2021–22 Budget that it would introduce a patent box to tax corporate income derived from eligible Australian patents in the medical and biotechnology sectors, at a concessional rate of 17 per cent. The policy measure was not enacted through law and has since lapsed.

6 A Roadmap to R&D intensity of 3% of GDP

The application of the innovation policy toolkit to Australia suggests a number of actions the Australian Government should take to lift Australia's R&D intensity towards 3 per cent of GDP by approximately 2035.

This section presents the specific recommendations to the Australian Government – the recommended reforms the Australian Government should take under the innovation policy toolkit are summarised in Table 5 as a 10-year (decadal) "roadmap" – setting out a staged approach to achieve an R&D intensity of 3 per cent of GDP. The sequencing of the recommendations reflects a combination of an assessment of the lead time to maximise impact on R&D intensity for each recommendation and an acknowledgement of the current tight fiscal environment.

The roadmap represents a national plan focussed on lifting R&D intensity, especially by the business sector given it provides the majority of R&D expenditure in Australia, and the plan specifies reforms to boost support by higher education and universities in particular, in achieving the national target.

Roadmap Recommendations

Immediate term reforms (to be implemented within 1–2 years)

Step one in the Roadmap is for the Australian Government formally to adopt a target of 3 per cent of GDP invested in R&D by 2035. A national target on R&D is supported by the Australian Universities Accord Review Panel (2024, p. 28) who recommend 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".*

The Panel also recommends a formal cross-portfolio examination of national research funding with a view to increasing Australia's capacity to maximise its R&D competitiveness for economic gain, and environmental, cultural and social good.

While the Australian Universities Accord Review Panel does not specify a figure for the R&D target, Section 3 of this report shows that a 3 per cent of GDP target for R&D is a conservative and economically justifiable target when the estimated optimal level of R&D for economic, environmental, cultural and social good in Australia is 3.67 per cent of GDP, and given the evidence of high societal returns to R&D in Australia.

The Australian Government's *Measuring What Matters Framework* should be updated to include the new R&D intensity target. We recognise that an R&D intensity target is not an objective in itself, but R&D intensity is a strong indicator of an economy's long-term innovation and productivity potential.

To measure progress on R&D intensity, the Australian Bureau of Statistics (ABS) should publish data on gross expenditure on R&D by the business, government, higher education and private non-profit sectors for the same financial year (currently sectoral R&D ABS publications are on a non-consistent year basis and hence national R&D intensity for any given year is inferred). Through the ABS, the Australian Government should report annually on progress made to achieving the national R&D target.

As stated earlier, the R&D target is ultimately a means to improve Australia's innovation and productivity capacity. Any additional public funding that is required to implement the Roadmap to its achievement must be effective and be monitored. While the ABS can assist in reporting on a more regular basis on progress to the target, there is also scope for improvements to the measurement of the broader economic, social, and environmental outcomes of public funding for research, which in turn can assist in better targeting future funding.

Recommendation 1

The Australian Government should formally adopt a national target of 3 per cent of GDP invested in R&D by 2035. The Australian Government's *Measuring What Matters Framework* should be updated to include the new target. The Australian Government should report annually on progress to achieve the target and also invest in improved measurement of the outcomes of publicly funded R&D.

Once a decadal R&D intensity target and commitment to measuring its progress is established, there are a suite of other policy actions (outlined below), as part of the Roadmap, to drive achievement of the R&D target and in turn support the innovation and productivity capacity of the Australian economy.

R&D grants, including targeting small firms

R&D activity involves knowledge creation as well as its application.

To promote these elements by businesses in Australia, **an immediate reform includes expanding the existing Business Research and Innovation Initiative (BRII) program to encapsulate a STTR type program targeting SMEs.** This will facilitate more R&D activity by SMEs in Australia and strengthen the collaboration between business and research institutions.

The Go8 with UniQuest at the University of Queensland have developed a proposal for a STTR program for Australia that complements existing government programs. In our consultations for the development of the Roadmap, there has been broad support for the STTR proposal from the business community, including the Business Council of Australia (BCA), Ai Group, ACCI, and COSBOA.

According to UniQuest, the benefits of a dedicated STTR program to raise R&D intensity for businesses include:

- Providing a "whole of government" approach.

- Assisting "technology pull through" by smaller businesses and their growth, including provision for SMEs to sub-contract R&D to other businesses.
- Supporting government procurement of products and services.
- Diversifying from the reliance on the R&DTI as a driver of business investment in research and engaging SMEs across all priority areas of the National Reconstruction Fund at scale.

We propose that Government expand the current Business Research and Innovation Initiative (BRII).

- Complementing the Australian Economic Accelerator, Trailblazer Universities Program, Industry Growth Program and National Reconstruction Fund.

While a STTR program for Australia would complement existing programs it would also fill a gap within the suite of existing programs. This is because the STTR program would uniquely involve a combination of: formal R&D partnerships between small businesses and research institutions in areas broader than the mandates of existing programs, direct links to Australian government agencies extramural R&D budgets; and focus on R&D activity much earlier in the technology readiness cycle.

Rather than introduce a new program for SME engagement with research institutions we propose that Government expand the current Business Research and Innovation Initiative (BRII). The BRII was modelled upon the US Small Business Innovation Research (SBIR) program and supports business to develop innovative solutions to public policy and service delivery challenges. In the US, the SBIR program was expanded to a complementary STTR program to access the research capability of research institutions to assist companies to develop early stage TRL opportunities and provide SMEs surety of access to the underpinning IP within the research institutions. Our proposal is to expand the current BRII to encapsulate a complementary STTR program.

We propose both the Australian Government expand the current BRII to encapsulate a complementary STTR program focussed on direct R&D grants as well as leveraging existing R&D tax incentives because grants and tax incentives each have their own strengths and can complement each other. Evidence from the International Monetary Fund (2016) in particular, suggests that direct R&D grants help are helpful in supporting the research component of R&D – the early phase of innovation related activities – whereas tax incentives provide broader incentives for all businesses to invest in R&D.

Recommendation 2

The Australian Government expand the current Business Research and Innovation Initiative to encapsulate a complementary Small Business Technology Transfer program to incentivise small businesses to engage with Australian research institutions on R&D collaboration.

Leveraging R&D tax incentives

Recognising the R&DTI regime is well regarded as being an effective facilitator of additional R&D investment and has established parameters, its effectiveness would be further boosted by offering businesses that qualify for the R&DTI and who enter formal R&D collaborations with an Australian research institution, an additional equity or debt finance incentive from the National Reconstruction Fund (NRF).

This reform focusses on business R&D at the applied/development end of the R&D spectrum, and hence more likely to be within the NRF mandate to achieve a target portfolio rate of return of 2–3 per cent above the 5-year Australian Government Bond rate over the medium to long term.

Assessment of the R&D activity can continue to be done through the administration of the R&DTI program by the Department of Industry, Science and Resources/ATO and formal collaboration with an Australian research institution can also be assessed through this administration.

Recommendation 3

Leverage the Research and Development Tax Incentive (R&DTI) by offering businesses that qualify for the R&DTI and enter into formal R&D collaboration with an Australian research institution, an additional equity or debt finance incentive from the National Reconstruction Fund.

Skilled immigration

To achieve the proposed lifting of Australia's R&D intensity requires a suitably skilled research and development workforce. Having a national target to significantly lift R&D intensity without commensurate growth of the research workforce will result in the target not being met and/or higher wages accruing to researchers that would be in high demand. So, supply side measures to increase the R&D workforce are needed as part of the national strategy. The research workforce needs to be expanded from both domestic and international sources.

In terms of international sources for expanding Australia's research workforce, the Australian Government's intention to introduce a new Skills in Demand visa, under its recent *Migration Strategy*, provides a promising avenue. The objective of augmenting Australia's research workforce can be pursued by the Australian Government using the new Skills in Demand visa to provide direct and expedited permanent residency for international students obtaining a PhD at an Australian university.

In 2022 there were approximately 4,000 international students graduating with a PhD from a higher education institution in Australia (approximately 50 per cent of these are from Go8 universities). Not all international students graduating with a PhD will want to become permanent residents of Australia, but those that do will significantly contribute to the scale and capability of the domestic research workforce, especially in critical areas such as STEM.

The Australian Government has also announced a new National Innovation visa to target exceptionally talented

migrants for sectors of national importance. This National Innovation visa should recognise the importance of researchers to boosting Australia's knowledge capacity and therefore include explicit provision for the attraction and retention of experienced high-quality international researchers. These initiatives should complement the expansion of Australia's research workforce from domestic sources, discussed in the next sub-section.

Recommendation 4

Boost Australia's R&D workforce through skilled migration:

- Under the new Skills in Demand visa as part of the *Migration Strategy,* provide direct and expedited permanent residency for international students obtaining a PhD at an Australian university.
- Through the new National Innovation visa, include specific provision for the attraction and retention of high-quality international researchers.

STEM supply through universities

Boosting Australia's research workforce also requires that the Australian Government acts on the Australian Universities Accord Review Panel (2024) recommendation to increase government funding to support STEM courses to reduce the negative impacts of the existing Job-ready Graduates (JRG) package. The Panel recommends that any early Australian Government investment in response to the Accord should prioritise the STEM disciplines.

Further immediate reforms related to the research workforce include ensuring stipends and scholarships for higher degree by research (HDR) students are attractive, to retain and grow the pool of researchers in Australia. This recommendation is also made by the Australian Universities Accord Review Panel (2024). The 2024 stipends are AU$35,411 per annum tax-free for full-time students, and AU$17,705 per annum, taxable, for part-time students, and these should be raised to at least be above relevant national minimum wages.

More broadly these recommendations are consistent with the Australian Universities Accord Review Panel (2024) recommendation that a National Research Workforce Development Strategy be developed by the end of 2026, including a focus on research career pathways for HDR students into and out of universities.

Recommendation 5

Further invest in the domestic R&D workforce by:

- Prioritising reforming university funding rates and levels for STEM related fields of education to raise STEM supply through universities.
- Ensuring stipends and scholarships for higher degree by research students are attractive, to retain and grow the pool of researchers in Australia.

Universities incentives

On the basis of a current government review, the Australian Government should enhance the usefulness of the *Higher Education Research Commercialisation Intellectual Property Framework* by revising provisions of the template agreements that the Australian Government has developed, intended to make it easier for businesses and research bodies to come to contractual arrangements. In particular, the revisions should address inappropriate liability provisions and unreasonable intellectual property indemnities for universities as public institutions, which have made these template agreements less attractive to use.

Furthermore, it is important that these template agreements continue to remain voluntary, allowing for entities to have the flexibility of using individualised agreements. The aim should be for the framework to tangibly boost R&D performed by the business sector and collaboration between businesses and higher education institutions.

Recommendation 6

On the basis of a government review underway, boost the effectiveness of the *Higher Education Research Commercialisation Intellectual Property Framework* by revising the template agreements' provisions to address inappropriate liability provisions and unreasonable intellectual property indemnities for universities as public institutions. Maintain these agreements as voluntary to use.

Medium term reforms (to be implemented within 3–5 years)

Access to (private) finance

The Australian Government is in the process of legislating an objective of superannuation that encompasses "to preserve savings to deliver income for a dignified retirement, alongside government support, in an equitable and sustainable way" (Chalmers, 2023b). This objective is to be aligned with superannuation trustees' fiduciary duties and not change existing trustee obligations.

The $3.5 trillion superannuation industry is a growing source of capital in Australia's economy and within their mandates and duties to members, some superannuation funds such as Hostplus are already investing in early-stage seed investments. Recent media reports also point to Australian superannuation funds increasingly investing in United Kingdom early-stage ventures associated with UK university research (van Leeuwen, 2024). The Australian Government is also providing support through its Early Stage Venture Capital Limited Partnerships (ESVCLP).

The United Kingdom has recently announced reforms to its financial services sector as part of its "Mansion House Reforms" that include an agreement between nine of the UK's largest defined contribution pension funds to commit to allocating 5 per cent of assets in their default funds to unlisted equities by 2030 (HM Treasury, 2023).

Estimates suggest that if all defined contribution funds follow this lead, then an additional £50 billion of investment would be facilitated. For defined benefit funds such as local government pension funds, a consultation is also underway in the UK on setting a target to double existing investments in private equity to 10 per cent, which could facilitate £25 billion in additional investment by 2030.

The United Kingdom experience also highlights the development of "patient capital" (defined as businesses that are focussed on funding academic-associated start-ups) (Hickson, 2016). These businesses typically target university inventions where it is difficult to attract seed-funding. Unlike traditional venture capital, these businesses reinvest earnings back into new start-ups and their existing portfolio of start-ups in order to make returns over longer time periods.

In the Australian context, to further build the contribution of superannuation funds in boosting investment in early-stage R&D ventures, including collaborations between SMEs and Australian universities, the Australian Government should facilitate the presence of additional intermediaries and aggregators (between superannuation funds as investors and the early-stage R&D-based ventures as investees). The role of these intermediaries would be to ultimately broker the relationship between the two so that promising early-stage R&D-based ventures are brought to the attention of Australian superannuation funds for consideration. The Australian Government could facilitate this through its existing programs related to early-stage investment, or a new dedicated program.

Recommendation 7

The Australian Government should facilitate the presence of additional intermediaries and aggregators (between superannuation funds as investors and the early-stage enterprises as investees) to encourage investment in R&D by Australian superannuation funds.

Business linkages with research institutions

It is critical that research linkages between business and the research sector also encapsulate collaboration on utilisation of research infrastructure. The Australian Government could also facilitate international opportunities for Australia's R&D, including access to globally leading-edge research consortia and collaborations.

The final report of the Australian Universities Accord Review Panel (2024) recommends the Australian Government provide stable and predictable ongoing funding for the National Collaborative Research Infrastructure Strategy (NCRIS). Building on this, in the three to five year period of our proposed Roadmap, the Australian Government can maintain momentum towards an R&D intensity target by securing and strengthening investment in the NCRIS program and making national research infrastructure a catalyst for further business-research collaboration by:

- Adopting a life-cycle approach to funding for national research infrastructure, capturing ongoing maintenance and operation costs of the infrastructure and the skilled workforce required to support world leading facilities. The emphasis would be on identifying opportunities to build scale, taking advantage of local research strengths and critical mass, including those in the private sector and broader community.

The final report of the Australian Universities Accord Review Panel (2024) recommends the Australian Government provide stable and predictable ongoing funding for the National Collaborative Research Infrastructure Strategy (NCRIS).

- Specifying a requirement that custodians and users of the national infrastructure, wherever possible, seek out, promote, and enable productive engagement and partnerships between researchers, industry and the broader community.
- Including explicit provision for researchers to access priority international research infrastructure.

In addition, the Australian Government should pursue Australia's participation in globally leading-edge research consortia and collaborations such as *Horizon Europe*. This is important because it opens up new opportunities globally, and further integrates Australian businesses and researchers into R&D globally. A recent example of an Australian-led initiative in this area is the $40 million Global Science and Technology Diplomacy Fund, providing opportunities for collaboration with Indonesia, Malaysia, Singapore, Thailand, Vietnam, New Zealand, Japan, the Republic of Korea and Brazil.

Recommendation 8

Facilitate further collaboration between businesses and the research sector, including:

- Strengthen the National Collaborative Research Infrastructure Strategy program by adopting a life-cycle approach to funding for national research infrastructure; specifying a requirement to aim for productive engagement and partnerships between researchers, industry and the broader community; and including explicit provision for researchers to access priority international research infrastructure.
- Pursue Australia's participation in globally leading-edge research consortia and collaborations (such as *Horizon Europe*).

Trade and competition policies

Given the high rating of trade openness by Bloom et al. in contributing to innovation and knowledge diffusion, the Australian Government should also act on the Productivity Commission (2023a) recommendations on trade reforms. These include reducing Australia's statutory import tariff levels to zero; progressively removing Australia's anti-dumping and countervailing measures; increasingly accepting product standards adopted in other leading economies as 'deemed to comply'; and reducing non-tariff barriers to trade in services.

Achieving progress to the target can also be strengthened over the medium term by, on the basis of the Treasurer's announced 2-year *Competition Review*, ensuring proposals for reform explicitly consider implications for innovation and rebuild the momentum achieved by competition policy reforms in the late 1990s and early 2000s.

Recommendation 9

On the basis of the Treasurer's recently announced Competition Review, ensuring that proposals for reform explicitly consider implications for long-term innovation in Australia and rebuild the momentum achieved by previous competition policy reforms. In addition, where appropriate in the Australian context, implement Productivity Commission recommendations to progressively remove Australia's anti-dumping and countervailing measures; increasingly accept product standards adopted in other leading economies as 'deemed to comply'; and reduce non-tariff barriers to trade in services.

Longer term reforms (to be implemented within 6–10 years)

Mission-oriented policies

The early success and focus of the Medical Research Future Fund (MRFF) on translation of health and medical research is a template for other areas of research in Australia. The R&D intensity target could therefore be further achieved by over the longer-term by establishing a future fund for other fields of research.

A fund for research in fields of research outside of the MRFF with a strong link to basic research is important because basic research can deliver the pipeline of ideas, technologies and processes that be built upon in the future. Indeed, in Australia business expenditure on basic research is only 10 per cent of total business R&D expenditure.

Recommendation 10

Establish a fund similar to the Medical Research Future Fund (MRFF) focussed on fields of research outside of the MRFF.

Co-location of businesses and research organisations

In the medium term all levels of government should work together to incentivise co-location of "science-based" universities and businesses. The evidence discussed earlier suggests the development of "knowledge precincts" creates positive innovation and productivity spillovers to businesses. The Australian Government should work with States/Territories and local government to coordinate existing programs and support to incentivise development of knowledge precincts through co-location of Australian universities and businesses.

Recommendation 11

Work with States/Territories and local government to coordinate existing programs and support to incentivise development of knowledge precincts through co-location of Australian universities and businesses.

Intellectual property reforms

R&D most effectively translates to innovation and productivity if R&D activity involves knowledge creation as well as its adoption and adaption. Adoption and adaption of R&D by businesses, particularly SMEs that have more limited financial resources, can be stifled by research which is non-rival but excludable. That is, excludable by access to research being limited to only paying customers.

The Australian Government should implement open access reforms to research principally funded by the Australian Government, in a way that does not result in extraction of rents by publishers from researchers and readers but acts to increase knowledge available to businesses and improve diffusion of knowledge. Open access to this type of research is raised as a reform by the Productivity Commission (2023a), but as Holden (2021) points out, the way open access is implemented is important so as to avoid rent extraction. For example, Holden points out that publishers requiring researchers to pay for open access to their published works can result in large fees being paid to publishers that could otherwise be used to fund additional research.

Recommendation 12

Implement open access to research principally funded by the Australian Government in a way that does not result in extraction of rents by publishers from researchers and readers, but acts to increase knowledge available to businesses and improve diffusion of knowledge.

The Australian Government should implement open access reforms to research principally funded by the Australian Government, in a way that does not result in extraction of rents by publishers from researchers and readers but acts to increase knowledge available to businesses and improve diffusion of knowledge.

Table 5: Recommendations to the Australian Government – a decadal Roadmap of reforms to achieve R&D intensity of 3% of GDP

Roadmap horizon	Reform recommendations to the Australian Government
Immediate term implement within 1–2 years	**1.** Formally adopt a national target of 3 per cent of GDP invested in R&D by 2035. The Australian Government's *Measuring What Matters Framework* should be updated to include the new target. The Australian Government should report annually on progress to achieve the target and also invest in improved measurement of the outcomes of publicly funded R&D. **2.** The Australian Government expand the current Business Research and Innovation Initiative to encapsulate a complementary Small Business Technology Transfer program to incentivise small businesses to engage with Australian research institutions on R&D collaboration. **3.** Leverage the Research and Development Tax Incentive (R&DTI) by offering businesses that qualify for the R&DTI and enter into formal R&D collaboration with an Australian research institution, an additional equity or debt finance incentive from the National Reconstruction Fund (NRF). **4.** Boost Australia's R&D workforce through skilled migration: » Under the new Skills in Demand visa as part of the *Migration Strategy*, provide direct and expedited permanent residency for international students obtaining a PhD at an Australian university. » Through the new National Innovation visa, include specific provision for the attraction and retention of high-quality international researchers. **5.** Further invest in the domestic R&D workforce by: » Prioritising reforming university funding rates and levels for STEM related fields of education to raise STEM supply through universities. » Ensuring stipends and scholarships for higher degree by research students are attractive to retain and grow the pool of researchers in Australia.

Roadmap horizon	Reform recommendations to the Australian Government
	6. On the basis of a government review underway, boost the effectiveness of the *Higher Education Research Commercialisation Intellectual Property Framework* by revising the template agreements provisions to address inappropriate liability provisions and unreasonable intellectual property indemnities for universities as public institutions. Maintain these agreements as voluntary to use.
Medium term implement within 3–5 years	**7.** The Australian Government should facilitate the presence of additional intermediaries and aggregators (between superannuation funds as investors and the early-stage enterprises as investees) to encourage investment in R&D by Australian superannuation funds. **8.** Facilitate further collaboration between businesses and the research sector, including: » Strengthen the National Collaborative Research Infrastructure Strategy program by adopting a life-cycle approach to funding for national research infrastructure; specifying a requirement to aim for productive engagement and partnerships between researchers, industry and the broader community; and including explicit provision for researchers to access priority international research infrastructure. » Pursue Australia's participation in globally leading-edge research consortia and collaborations (such as *Horizon Europe*). **9.** On the basis of the Treasurer's recently announced Competition Review, ensuring that proposals for reform explicitly consider implications for long-term innovation in Australia and rebuild the momentum achieved by previous competition policy reforms. In addition, where appropriate in the Australian context, implement Productivity Commission recommendations to progressively remove Australia's anti-dumping and countervailing measures; increasingly accept product standards adopted in other leading economies as 'deemed to comply'; and reduce non-tariff barriers to trade in services.
Longer-term implement within 6–10 years	**10.** Establish a fund similar to the Medical Research Future Fund (MRFF) focussed on fields of research outside of the MRFF. **11.** Work with States/Territories and local government to coordinate existing programs and support to incentivise development of knowledge precincts through co-location of Australian universities and businesses. **12.** Implement open access to research principally funded by the Australian Government in a way that does not result in extraction of rents by publishers from researchers and readers, but acts to increase knowledge available to businesses and improve diffusion of knowledge.

7 Conclusion

With productivity growth at a 60-year low, and other significant challenges and opportunities such as transitioning to a net zero economy, addressing ageing of the population, and taking full advantage of emerging technologies such as artificial intelligence and quantum computing, now is the time to seize the opportunity to boost Australia's R&D intensity.

R&D is a long-term investment in the innovative and productivity capacity of Australia. By failing to make optimal investment in R&D today, the negative impacts on innovation capacity and productivity will be experienced many years into the future. **As a nation we can collectively shrug our shoulders, or we can take decisive action and secure our future prosperity.**

The Go8 has set out a decadal Roadmap of recommended reforms, supported by evidence based on an innovation policy toolkit, that the Australian Government should adopt to lift Australia's R&D intensity to 3 per cent of GDP.

The roadmap starts with the Australian Government updating the *Measuring What Matters Framework* introduced in 2023 to formally adopt as government policy a target of 3 per cent of GDP invested in R&D by 2035 as a national priority. R&D intensity is a strong indicator of an economy's long-term innovation and productivity potential. The evidence shows the social returns to R&D in Australia in the form of innovation and productivity are high and Australia's current intensity of 1.68 per cent of GDP is less than half the long-run optimal level, impeding our future prosperity.

Now is the time for action.

The roadmap starts with the Australian Government updating the Measuring What Matters Framework *introduced in 2023 to formally adopt as government policy a target of 3 per cent of GDP invested in R&D by 2035 as a national priority.*

References

Acemoglu, D., Akcigit, U., Alp, H., Bloom, N., & Kerr, W. (2018). 'Innovation, reallocation, and growth', *American Economic Review*, 108(11), pp 3450–3491. https://doi.org/10.1257/aer.20130470

Albanese, A, the Hon. (2024). *A future made in Australia*. Speech Transcript. Queensland Media Club, Brisbane, 11 April. https://www.pm.gov.au/media/future-made-australia

Albanese, A, the Hon, & Chalmers, J, the Hon. (2024). *Investing in a future made in Australia*. Joint Media Release, 14 May. https://www.pm.gov.au/media/investing-future-made-australia

AlphaBeta. (2020). *Australian business investment in innovation: levels, trends, and drivers*. Prepared for the Office of Innovation & Science Australia, January.

Australian Bureau of Statistics, ABS. (2022). *Innovation in Australian business*, https://www.abs.gov.au/statistics/industry/technology-and-innovation/innovation-australian-business/2020–21#key-statistics

Australian Bureau of Statistics, ABS. (2024). *Counts of Australian businesses, including entries and exits*. https://www.abs.gov.au/statistics/economy/business-indicators/counts-australian-businesses-including-entries-and-exits/latest-release

Australian Government Department of Treasury. (2023). *Working future: the Australian Government's white paper on jobs and opportunities*. https://treasury.gov.au/sites/default/files/2023-10/p2023-447996-working-future.pdf

Australian Government Department of Education. (2022). *Higher education research commercialisation intellectual property framework: practical guide*. https://www.education.gov.au/hercip/resources/herc-ip-framework-practical-guidance

Australian Government Department of Home Affairs. (2023a). *Review of the migration system: final report*. https://www.homeaffairs.gov.au/reports-and-pubs/files/review-migration-system-final-report.pdf

References

Australian Government Department of Home Affairs. (2023b). *Migration Strategy*. https://immi.homeaffairs.gov.au/programs-subsite/migration-strategy/Documents/migration-strategy.pdf

Australian Government Department of Industry, Innovation and Science. (2018). *Statement of principles for Australian innovation precincts: place-based partnerships building on competitive strengths*. https://www.industry.gov.au/sites/default/files/October%202018/document/pdf/statement-of-principles-australian-innovation-precincts.pdf

Australian Government Department of Industry, Innovation, Science, Research and Tertiary Education. (2013). *A plan for Australian jobs: the Australian Government's industry and innovation statement*. https://www.voced.edu.au/content/ngv%3A56585

Australian Government Department of Treasury. (2023). *Intergenerational Report 2023: Australia's future to 2063*. https://treasury.gov.au/sites/default/files/2023-08/p2023-435150.pdf

Australian Government Department of Treasury. (2024). *Budget 2024–25, Budget Strategy and Outlook, Budget Paper No. 1, https://budget.gov.au/content/bp1/download/bp1_2024-25.pdf*

Australian Law Reform Commission. (2010). *Intellectual property ownership*. https://www.alrc.gov.au/publication/genes-and-ingenuity-gene-patenting-and-human-health-alrc-report-99/11-publicly-funded-research-and-intellectual-property/intellectual-property-ownership/

Australian Research Council. (2022). *Linkage Projects*. https://www.arc.gov.au/funding-research/funding-schemes/linkageprogram/linkage-projects

Australian Universities Accord Review Panel. (2023). *Australian Universities Accord Interim Report*, Canberra.

Australian Universities Accord Review Panel. (2024). *Australian Universities Accord Final Report*, Canberra.

Bakhtiari, S., & Breunig, R. (2017). 'The role of spillovers in research and development expenditure in Australian industries'. *Research Paper 2/2017*, Department of Industry, Innovation and Science.

Barlevy, G. (2005). 'Why don't recessions encourage more R&D spending?', *Chicago Fed Letter*, The Federal Reserve Bank of Chicago, number 220, November.

Bloom, N., Van Reenen, J., & Williams, H. (2019). 'A toolkit of policies to promote innovation', *Journal of Economic Perspectives*, 33(3), Summer, pp. 163–184.

Business Council of Australia. (2023). *Australian Universities Accord Interim Report*, September. https://assets.nationbuilder.com/bca/pages/7340/attachments/original/1694578810/Business_Council_of_Australia_Submission_Universities_Accord_Interim_Report.pdf?1694578810

Carvalho, A. (2018). 'Wishful thinking about R&D policy targets: what governments promise and what they actually deliver', *Science and Public Policy*, 45(3), pp. 373–391.

Centre for International Economics. (2017). *Australian trade liberalisation: analysis of the economic impacts*. https://www.dfat.gov.au/sites/default/files/cie-report-trade-liberalisation.pdf

Chadha, J.S, & Venables, T. (2023). 'Investing for the long-run', *Productivity Insights Paper no. 019*, The Productivity Institute. https://www.productivity.ac.uk/wp-content/uploads/2023/11/PIP019-Investing-for-the-long-run-FINAL-Nov-2023.pdf

Chalmers, the Hon, J. (2023a). *A more dynamic and competitive economy*. https://ministers.treasury.gov.au/ministers/jim-chalmers-2022/media-releases/more-dynamic-and-competitive-economy

Chalmers, J, the Hon. (2023b). *Superannuation (Objective) Bill 2023, Explanatory Memorandum*. The Parliament of the Commonwealth of Australia, House of Representatives, 2022–23.

Chalmers, J, the Hon. (2024). *Tariff reform to cut costs for businesses and boost productivity*. https://ministers.treasury.gov.au/ministers/jim-chalmers-2022/media-releases/tariff-reform-cut-costs-businesses-and-boost

References

Chen, Z., Liu, Z., Suárez Serrato, J.C., & Xu, D.Y. (2021). 'Notching R&D investment with corporate income tax cuts in China', *American Economic Review*, 111(7), pp. 2065–2100. https://doi.org/10.1257/aer.20191758

Choi, J. (2022). 'Do government incentives to promote R&D increase private R&D investment?', *The World Bank Research Observer*, no. 37, pp. 204-228.

Cooperative Research Australia. (2024). 'Advancing Australian industry: Cooperative Research Australia (CRA) welcomes investment in twenty one new cooperative research centre projects', *Media Release*, 12 February.

Commonwealth Scientific and Industrial Research Organisation. (2021). *CSIRO Futures: quantifying Australia's returns to innovation,* Canberra.

Commonwealth Scientific and Industrial Research Organisation. (2023). 'Australian institutes spearhead global efforts in clean energy innovation'. *News Release*, 19 September 2023.

Davis, G., & Tunny, G. (2019). 'International comparisons of research and development', Australian Treasury, https://treasury.gov.au/sites/default/files/2019-03/07_International_RD.pdf

de Rassenfosse, G., & Webster, E. (2016). 'An assessment of Australia's absorptive capacity', Melbourne Institute of Applied Economic and Social Research and Intellectual Property Research Institute of Australia, The University of Melbourne, https://www.swinburne.edu.au/media/swinburneeduau/research/research-centres/cti/reports/rassenfoss-webster-assessment-of-australia's-absorptive-capacity-2016.pdf

Elnasri, A., & Fox, K.J. (2017). 'The contribution of research and innovation to productivity'. *Journal of Productivity Analysis*, 47, 291–308.

Falk, M. (2006). 'What drives business research and development (R&D) intensity across Organisation for Economic Co-operation and Development (OECD) countries?', *Applied Economics*, 38(5), pp. 533–547.

Ferris, B., Finkel, A., & Frasrer, J. (2016). *Review of the R&D Tax Incentive*, April. https://www.industry.gov.au/sites/default/files/May%202018/document/pdf/research-and-development-tax-incentive-review-report.pdf

Hickson, T. (2016). 'Patient capital: A new way of funding the commercialisation of early-stage UK science', Imperial Innovations Group.

Higher Education Funding Council for England. (2006). 'Higher Education Innovation Fund: summary evaluation of the first round (2001-05)'. https://dera.ioe.ac.uk/id/eprint/5902/1/rd03_06.pdf

HM Treasury. (2023). 'Chancellor's Mansion House reforms to boost typical pension by over £1,000 a year'. https://www.gov.uk/government/news/chancellors-mansion-house-reforms-to-boost-typical-pension-by-over-1000-a-year

Holden, R. (2021). 'Open access, market power, and rents', *VerfBlog*, 2021/12/21, https://verfassungsblog.de/open-access-market-power-and-rents/,DOI: 10.17176/20211221–235850-0

Husic, E, the Hon. (2024). *Grants open for new Cooperative Research Centres Projects*. *https://www.minister.industry.gov.au/ministers/husic/media-releases/grants-open-new-cooperative-research-centres-projects*

Industry Innovation and Science Australia. (2023). *Barriers to collaboration and commercialisation*, Australian Government, Canberra.

Innovation and Science Australia. (2017). *Australia 2030: prosperity through innovation*, Australian Government, Canberra.

International Monetary Fund. (2016). 'Fiscal policies for innovation and growth', Fiscal Monitor: Acting Now, Acting Together, April. https://www.imf.org/en/Publications/FM/Issues/2016/12/31/Acting-Now-Acting-Together

International Monetary Fund. (2021). 'Research and innovation: fighting the pandemic and boosting long-term growth'. *World Economic Outlook*. October.

References

International Monetary Fund. (2024). 'Expanding frontiers: fiscal policies for innovation and technology diffusion'. *Fiscal Monitor: Fiscal Policy in the Great Election Year.* Washington, DC, April.

Jaumotte, F., & Pain, N. (2005). 'From ideas to development: the determinants of R&D and patenting', *OECD Economics Department Working Papers*, no. 457, December. https://www.oecd-ilibrary.org/economics/from-ideas-to-development_702226422387

Jones, C.I., & Williams, J.C. (1998). 'Measuring the social return to R & D', *The Quarterly Journal of Economics*, 113(4), pp. 1119-1135.

Organisation for Economic Co-operation and Development. (2013). 'New sources of growth: knowledge-based capital – key analyses and policy conclusions', *OECD Synthesis Report*. https://www.oecd.org/sti/inno/knowledge-based-capital-synthesis.pdf

Organisation for Economic Co-operation and Development. (2015). 'The impact of R&D investment on economic performance: a review of the econometric evidence'. *Working Party of National Experts on Science and Technology Indicators*.

Productivity Commission. (2022). *5-year Productivity Inquiry: the key to prosperity*. Interim Report, Canberra.

Productivity Commission. (2023a). *5-year Productivity Inquiry: advancing prosperity*. 5-year Productivity Inquiry Report, Canberra. https://www.pc.gov.au/inquiries/completed/productivity/report

Productivity Commission. (2023b). *5-year Productivity Inquiry: innovation for the 98%*, Vol. 5, Inquiry Report no. 100, Canberra.

Sanders, N., Scneier, B., & Eisen, N. (2024). 'How public AI can strengthen democracy'. *Brookings Commentary*. https://www.brookings.edu/articles/how-public-ai-can-strengthen-democracy/#:~:text=Publicly%20developed%20and%20owned%20AI,and%20sustainability%20of%20AI%20technology

Science & Technology Australia. (2023). *STEM career pathways. a report to the National Science and Technology Council*, Australian Government, Canberra.

Shu, P., & Steinwender, C. (2019). 'The impact of trade liberalization on firm productivity and innovation', *Innovation Policy and the Economy*, vol. 19, pp. 39-68. https://www.journals.uchicago.edu/doi/10.1086/699932#1st_rf117R

Tanewski, G, Kavourakis, J, Podolski, E, & Yusoff, I. (2021). *Post COVID policy options to enhance Australia's innovation capabilities: small business white paper 2021*, Institute of Public Accountants -Deakin University SME Research Centre.

Thomson, R., & Webster, B. (2024). 'The pathway to innovation needs a re-think', *InnovationAus.com,* https://www.innovationaus.com/the-pathway-to-innovation-needs-a-rethink/

Tulip, P. (2014). 'The effect of the mining boom on the Australian economy', *RBA Bulletin*, December quarter, pp. 1722.

United States Bureau of Labor Statistics. (2024a). *Quarterly census of employment and wages*. https://data.bls.gov/cew/apps/data_views/data_views.htm#tab=Tables

United States Bureau of Labor Statistics. (2024b). *Business employment dynamics*. https://www.bls.gov/bdm/bdmfirmsize.htm

United States National Research Board. (2022). *Research and development: U.S. trends and international comparisons*. Science and engineering indicators, NSB 2022-5. https://ncses.nsf.gov/pubs/nsb20225/u-s-business-r-d

United States Small Business Administration. (2020). *Leveraging America's Seed Fund*. https://www.sbir.gov/sites/default/files/SBA_SBIR_Overview_March2020.pdf

University of Melbourne. (2023). Intellectual property policy. https://policy.unimelb.edu.au/MPF1320/#section-17

References

van Ark, B, de Vries, K, & Pilat, D. (2023). 'Are pro-productivity policies fit for purpose?' *Working Paper No. 038*, The Productivity Institute. https://www.productivity.ac.uk/research/are-pro-productivity-policies-fit-for-purpose-productivity-drivers-and-policies-in-g-20-economies/

van Leeuwen, H. (2024). 'Why Hostplus is doing the UK differently', *The Australian Financial Review*, 18 March. https://www.afr.com/markets/equity-markets/why-hostplus-is-doing-the-uk-differently-20240318-p5fd3r

Verreynne M., Torres de Oliveira R., Mention A.-L. (with contributions from Lay J., Nguyen T., Ferraro S. and Machirori, T.L.). (2021). *Enablers and barriers to industry-research collaboration: a small and medium sized enterprise perspective*. CSIRO, Australia.

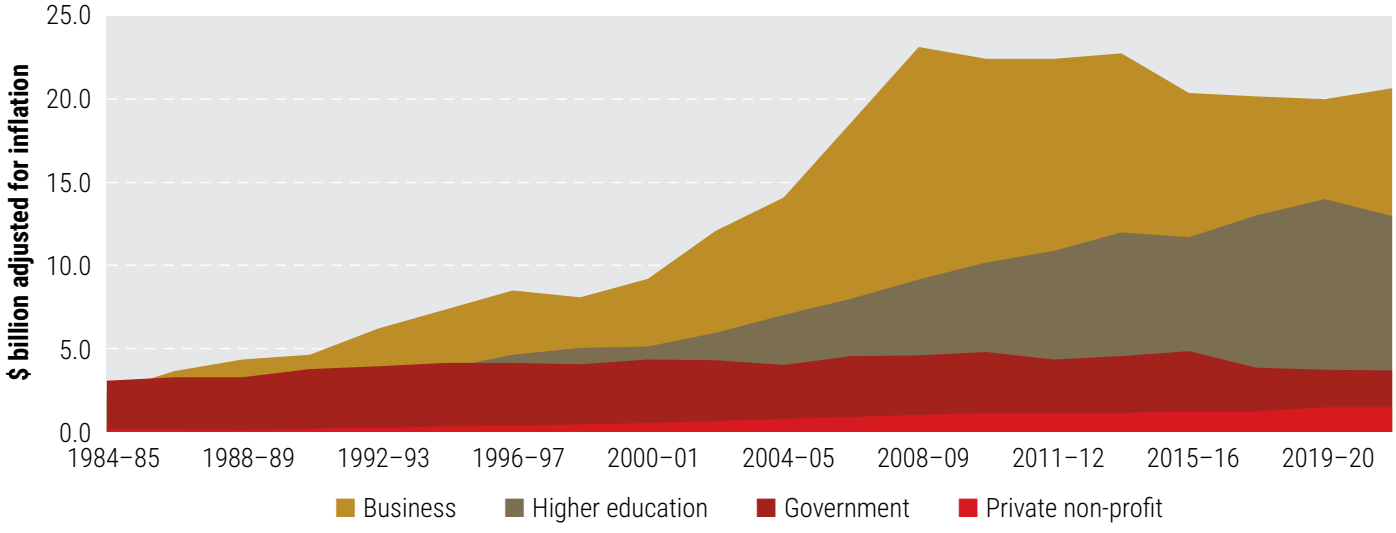
World Intellectual Property Organization. (2022). *Global Innovation Index 2022: What is the future of innovation driven growth?*, https://www.wipo.int/edocs/pubdocs/en/wipo-pub-2000-2022-en-main-report-global-innovation-index-2022-15th-edition.pdf

Appendix A: Australia's R&D expenditure performance

Chart A.1 shows the level of R&D expenditure in Australia since the mid-1980s in real (inflation adjusted) terms. After adjusting for inflation, we can see the tapering off of real growth, particularly business R&D, since 2008–09.

R&D intensity is defined as R&D expenditure as a per cent of GDP, both in nominal dollar terms. Consider the trends in R&D intensity by sector.[9]

Chart A.1: R&D expenditure in Australia in inflation adjusted terms ($ billion)



Data sources: ABS.

9 Recall for this report we define intensity to be expenditure on R&D by an industry as a percentage of GDP, so that the sum of the industry R&D intensities equals the national total R&D intensity figure.

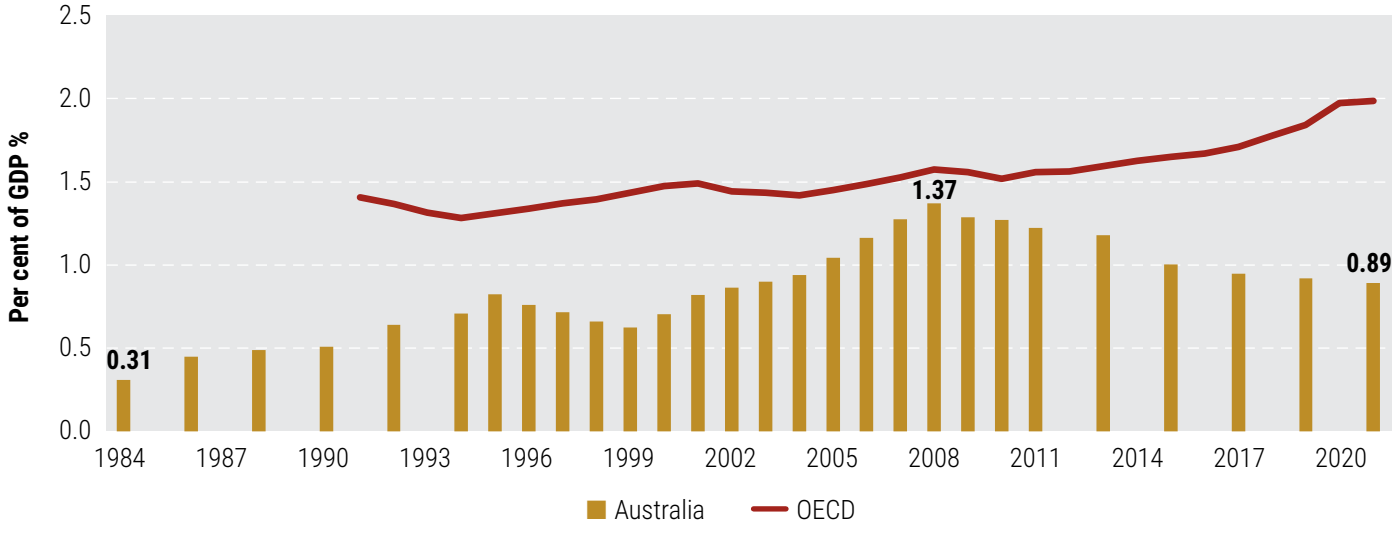
Business sector

Businesses in Australia are undertaking more R&D in absolute terms but not relative to GDP growth. This is shown in Chart A.2 as a decline since around the period of the global financial crisis.

The decline in business R&D intensity in Australia occurs from a peak of 1.37 per cent of GDP in 2008 to 0.89 per cent of GDP in 2021. Business R&D intensity in Australia as a percentage of GDP is not materially different in 2021 to what it was twenty years ago.

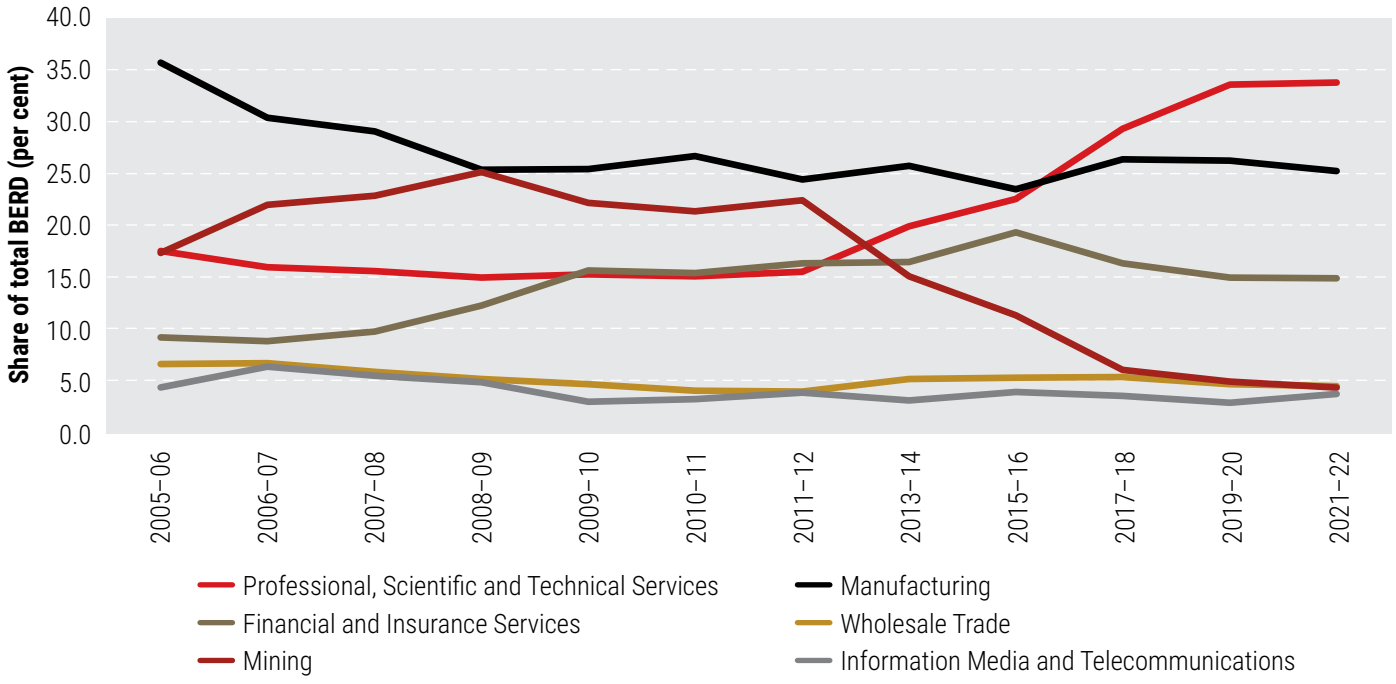
From an industry perspective, business R&D is concentrated in six industries that contributed around 86 per cent of the $20.6 billion in total business sector R&D expenditure in 2021–22. These include the professional, scientific and technical services (approximately 33.8 per cent or $7 billion of the $20.6 billion), manufacturing (25.2 per cent or $5.2 billion), financial and insurance services (14.9 per cent or $3.1 billion), wholesale trade (4.5 per cent or approximately $0.9 billion), mining

Chart A.2: Business sector R&D expenditure as a percentage of gross domestic product



Data sources: ABS and OECD MSTI database.

Chart A.3: Share of total business sector R&D expenditure by the current top six industry contributors



Data sources: ABS.

(4.3 per cent or approximately $0.9 billion) and information media and telecommunications (3.7 per cent or $0.8 billion).

Chart A.3 presents how the share of total business sector R&D expenditure (BERD) by these current top six industry contributors has changed over time. The chart shows the relative rise of professional, scientific and technical services R&D expenditure, with its share approximately doubling from 2005–06 to 2021–22. Manufacturing, which was the largest contributor in the mid-2000s experienced a relative decline up until the global financial crisis (GFC) period of 2008–09 before its share stabilised at around 25 per cent of total BERD.

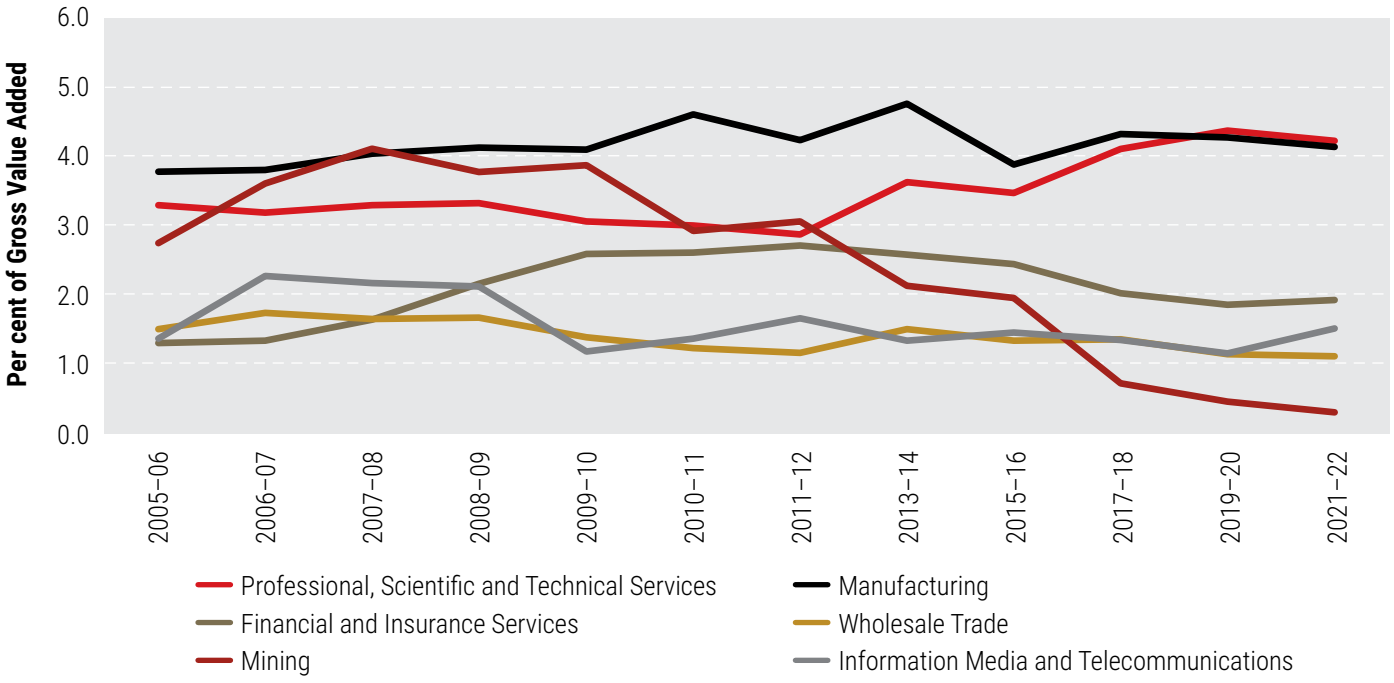
The cyclical pattern of the mining industry's share of total business sector R&D expenditure is also evident in the chart, rising from 2005–06 to 2008–09 (reaching 25 per cent of all business sector R&D expenditure in 2008–09), and then declining to 4.3 per cent in 2021–22. The financial and insurance services industry's share of total business sector R&D expenditure has also risen and has recently averaged around 16 per cent for more than a decade.

The mining industry's R&D intensity has been in decline as its overall investment in R&D has also been in long-term decline from $4.3 billion in 2008–09 to $0.8 billion in 2021–22.

In the unlikelihood of another mining investment boom in the next decade with a commensurate rise in its contribution to business sector R&D expenditure, the chart suggests the avenues to lifting activity may rely on achieving further increases from the professional, scientific and technical services industry. Moreover, also potentially revitalising the manufacturing industry's contribution, such as through the Future Made in Australia agenda, to around 30 per cent or higher, with some potential uplift also from the financial and insurance services industry.

The potential for uplift in R&D by the professional, scientific and technical services and manufacturing industries is illustrated in Chart A.4, which shows the R&D intensity (measured relative to gross value added of the industry) of the same six industries over time. In the decade since 2011–12, the

Chart A.4: R&D intensity over time of the current top six industry BERD contributors



Data sources: ABS.

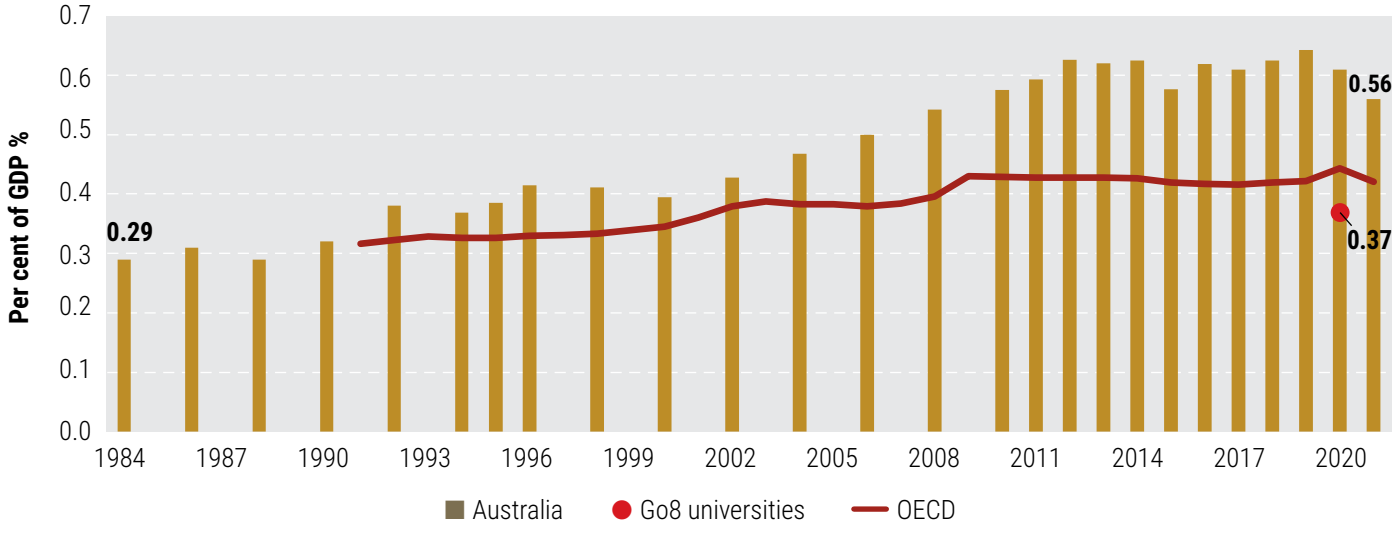
professional, scientific and technical services industry has increased its R&D intensity by around 1 percentage point. Also, over the longer sample period, the manufacturing industry has maintained its R&D intensity. The financial and insurance services industry's R&D intensity appears to follow long cycles, whereas the mining industry's R&D intensity has been in decline as its overall investment in R&D has also been in long-term decline from $4.3 billion in 2008–09 to $0.8 billion in 2021–22.

Higher education sector

In contrast to the business sector where R&D intensity is waning, the higher education sector in Australia has propped up Australia's overall R&D intensity but not by enough to redress the downward trend in total R&D intensity. The contribution of the higher education sector to R&D intensity is evident in Chart A.5.

Chart A.5 shows the rise in the contribution of higher education sector R&D expenditure in Australia from around 0.29 per cent of GDP in the mid-1980s to just on 0.56 per cent of GDP in 2021. This is a higher share of GDP than the OECD average. The pink circle show expenditure on R&D as a percentage of GDP by the Go8 universities in 2020 – around 60 per cent of higher education sector R&D expenditure in Australia is from the Go8 universities. The Go8 contribution to Australia (0.37 per cent of GDP) alone is almost on par to the average across the OECD (0.42 per cent of GDP).

Chart A.5: Higher education sector R&D expenditure as a percentage of gross domestic product



Data sources: ABS, OECD MSTI database, and Australia Government Department of Education (DOE).

Before examining trends in government and private not for profit sectors, it is worth delving into whether, given business sector R&D intensity in Australia has declined, what has occurred in business funding of higher education sector R&D expenditure in Australia, and how this compares to the OECD average.

This is an important issue because it provides some insight into whether business is increasingly "outsourcing" its R&D to higher education organisations and/or the degree of (financial) linkages between the business and higher education sectors in R&D activities.

Chart A.6 shows the percentage of higher education sector R&D expenditure in Australia funded by the business sector, compared to the share of higher education sector R&D expenditure funded by businesses across the OECD.

Chart A.6 shows that between the mid-1980s to the mid-2000s, the share of higher education sector R&D expenditure funded by businesses was rising from 1.60 per cent to 6.76 per cent. Over the last decade the percentage of higher education sector R&D expenditure in Australia funded by the business sector has remained largely stable, marginally rising from 4.9 per cent of all sources of funding in 2010 to 5.49 per cent in 2020.

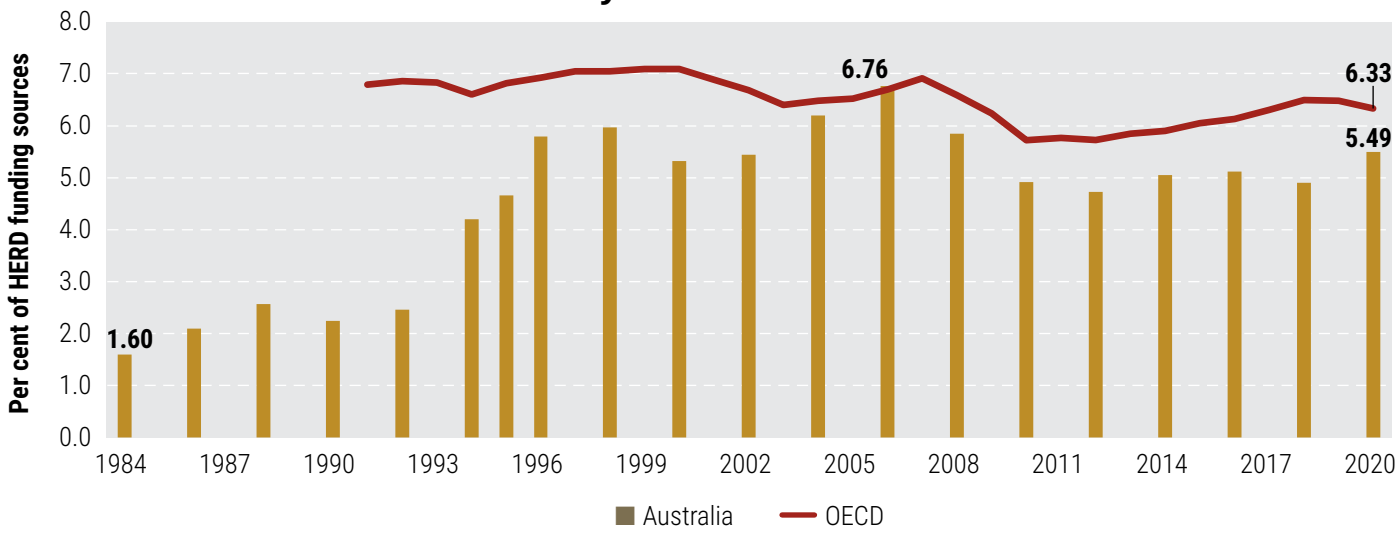
The OECD average of the percentage of higher education sector R&D expenditure funded by the business sector is only marginally higher than for Australia. Therefore, it does not appear that businesses in Australia have necessarily increased their "outsourcing" of R&D to higher education organisations by increasing their share of higher education sector R&D expenditure funding.

Government and private non-profit sectors

Turning to the government and private non-profit organisation sectors, Chart A.7 shows combined government and private non-profit organisation expenditure as a percentage of GDP in Australia has been declining over time but is not too different from the OECD average.

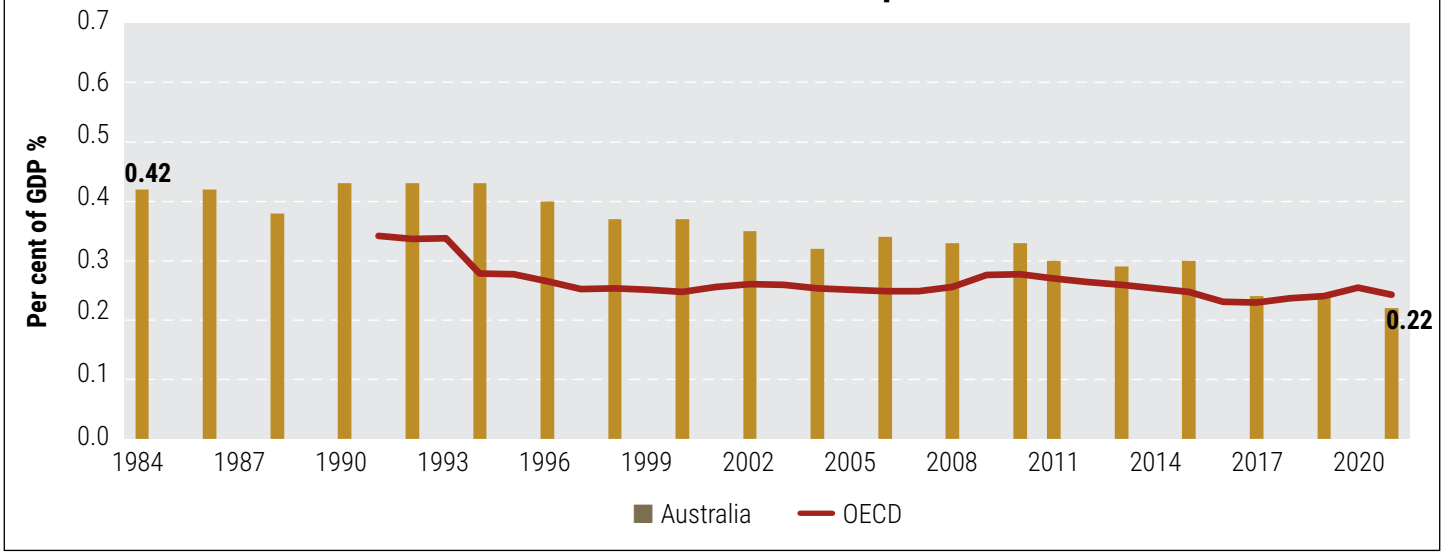
Appendix A: Australia's R&D expenditure performance

Chart A.6: Percentage of higher education sector R&D expenditure funded by the business sector



Data sources: ABS and OECD MSTI database.

Chart A.7: Combined government and private non-profit R&D expenditure in Australia and other economies, per cent of GDP



Data sources: ABS and OECD MSTI database.

Appendix B: The optimal level of R&D intensity in Australia

Jones and Williams (1998) set out an analytical framework for measuring the societal return on R&D, which allows for mapping to determine the degree to which actual investment in R&D differs to the societal optimal level of R&D. The framework provides the basis for estimating the ratio of the societal optimal level of R&D intensity to the actual level of R&D intensity using the following equation:

$$s^{optimal} = \frac{\lambda . g_{TFP}}{(r - (1 - \lambda)\, g_y)} \qquad (1)$$

In equation **(1)** $s^{optimal}$ is the optimal (from a societal return perspective) share of R&D in total output (in effect R&D expenditure divided by GDP, i.e., R&D intensity). It is a function of:

- λ which is a rate of research "duplication" (by definition $0 < \lambda \leq 1$) a negative "congestion" externality that Jones and Williams (1998) refer to as the "stepping on toes effect".
- g_{TFP} which is the "steady state" rate of growth of multifactor productivity (in effect the long-term average annual growth rate in multifactor productivity).
- r which is the real interest rate.
- g_y which is the "steady state" rate of growth of output (in effect the long-term average annual growth rate in real GDP).

Using data for the United States, Jones and Williams (1998) find that $\frac{s^{optimal}}{s^{actual}} \approx 4$, although they concede with more conservative values the ratio $\frac{s^{optimal}}{s^{actual}}$ could be around **2**. Nonetheless, they conclude "the optimal share of resources to invest in research is conservatively estimated to be two to four times larger than the actual amount invested by the U.S. economy. The extent of underinvestment is substantial, and could well be much larger" (Jones and Williams, 1998, p. 1133).

Appendix B: The optimal level of R&D intensity in Australia

What about Australia? We use the Jones and Williams (1998) methodology with long-term average annual growth rates to proxy the steady-state values for the parameters in equation **(1)** to arrive at an estimate of $s^{optimal}$ for Australia. We can then compare this estimated $s^{optimal}$ to s^{actual} for Australia. That is, as noted earlier, according to the most recent ABS publication s^{actual} (R&D intensity) is 1.68 per cent of GDP in 2021–22 (using total R&D expenditure), or alternatively, s^{actual} is 0.89 per cent of GDP in 2021–22 (using only business sector R&D expenditure).

The parameter values used are:

λ = 10 per cent. This parameter is difficult to pin down because of lack of direct empirical evidence for Australia, but based on figures for the United States, using a figure of 10 per cent is reasonable.

g_{TFP} = 0.41 per cent, which is the average annual growth rate in multifactor productivity for Australia from 2000 to 2019 (data to 2019 is used to exclude the recent COVID-19 period).

r = 3.7 per cent, which is the average annual real interest for Australia from 2000 to 2019 using an average annual commercial lending rate less inflation expectations proxied by the GDP deflator (data to 2019 is used to exclude the recent COVID-19 high inflation period).

g_y = 2.9 per cent, which is the average annual growth rate in real GDP for Australia from 2000 to 2019 (data to 2019 is used to exclude the recent COVID-19 period).

The ratio of the estimated societal optimal level of R&D intensity to the actual current level of R&D intensity for Australia using the Jones and Williams (1998) methodology is summarised in Table B.1.

The resulting estimate of the societal optimal level of R&D intensity is 3.67 per cent of GDP, marginally higher than the 3 per cent of GDP R&D intensity aspiration adopted by the Australian Government.

Table B.1: Estimates of the societal optimal level of R&D intensity for Australia

Estimated societal optimal level of R&D intensity	Ratio of estimated societal optimal level of R&D intensity to actual total R&D intensity *	Ratio of estimated societal optimal level of R&D intensity to actual business R&D intensity **
3.67	2.18	4.12

* Estimated ratio using s^{actual} **= 1.68 per cent** of GDP for total R&D expenditure.
** Estimated ratio using s^{actual} **= 0.89 per cent** of GDP for business sector R&D expenditure.

In summary, the estimates show the optimal level of R&D to GDP in Australia is 3.67 per cent of GDP and this is more than twice the current level of total R&D as a per cent of GDP (1.68 per cent) and more than four times the current level of business R&D as a per cent of GDP.

Appendix C: R&D intensity projections assumptions

The following are the assumed growth rates in sectoral R&D expenditure in each of the R&D intensity scenarios for Australia.

Average long term growth scenario – annual R&D expenditure growth by sector

Business	Higher education	Government	Private non-profit
9.4%	8.3%	3.7%	9.9%

Golden age growth scenario – annual R&D expenditure growth by sector

Business	Higher education	Government	Private non-profit
14.1%	10.1%	5.5%	12.6%

Augmented long term growth scenario – annual R&D expenditure growth by sector

Business	Higher education	Government	Private non-profit
10.4%	9.3%	4.7%	10.9%

Recent growth scenario – annual R&D expenditure growth by sector

Business	Higher education	Government	Private non-profit
1.4%	5.0%	0.6%	5.3%

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