Post COVID Policy Options to Enhance Australia's Innovation Capabilities

Small Business White Paper 2021

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DEAKIN BUSINESS SCHOOL

IPA INSTITUTE OF PUBLIC ACCOUNTANTS®

Background to the Institute of Public Accountants and the IPA Deakin University SME Research Centre

Introduction

The Institute of Public Accountants (IPA) is one of the three professional accounting bodies in Australia, representing over 42,000 accountants, business advisers, academics and students throughout Australia and in over 80 countries worldwide. The IPA Group is the largest accounting body representing the small business/SME sectors in the world.

The IPA takes an active role in the promotion of policies to assist the small business and SME sectors, reflecting the fact that approximately three-quarters of our members work in these sectors or are trusted advisers to small business and SMEs. The IPA pursues fundamental reforms which will result in boosting productivity growth and in easing the disproportionate regulatory compliance burden placed on small business.

In 2013, the IPA partnered with Deakin University to form the IPA-Deakin SME Research Centre. The strategic objectives of the Centre are to undertake research and derive actionable insights that:

- Are recognised as adding to the knowledge of SME experience, sector impact and performance;
- Are relevant and responsive to current and emerging economic conditions, including systemic shocks and their impact on the SME community;
- Informs public policy that provides the most supportive entrepreneurial eco-system;
- Builds capability and 'better and smarter' practices of SME practitioners, aspiring entrepreneurs and business owners; and
- Promotes the role of entrepreneurship and SME enterprises in advancing community wellbeing, prosperity and opportunity.

This Small Business White Paper (2021) builds upon a range of SME policy publications that the Centre has completed to date, such as the Australian Small Business White Papers in 2015 and 2018.

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Foreword

The findings reported in this Small Business White Paper raise some fundamental questions about the adequacy of Australia's innovation and research & development (R&D) system, particularly among entities in the small business sector. This important Deakin Business School report highlights that while Australia's longest unbroken run of economic growth from the early 1990s to early 2020, which was the subject of frequent boasting by incumbent government politicians, its economic performance was already demonstrating severe weaknesses before COVID was declared a pandemic by the World Health Organization (WHO) in March 2020.

Among the most serious of the problems is Australia's private sector's persistently poor performance on innovation and R&D, which have been long considered by economists to be primary drivers of a nation's productivity and growth. On almost every measure, Australian private companies have been lagging their global peers in this critical area for years. Australian business sector expenditure on R&D, for example, has been at or below OECD averages for most of the past two decades. And our businesses rank among the least effective in the OECD at introducing product and process innovations.

The Deakin Business School researchers show evidence that a lack of collaboration between the private sector and Australia's world-class universities and other public research institutions is one of the key reasons for Australian businesses' worsening performance relative to their global peers. The White Paper report demonstrates that a significant source of Australia's insipid performance on private sector innovation and R&D has been the failure of businesses to tap into the strong research culture in the nation's world-class universities and other government-funded research institutions, when compared with other countries. Sadly, a wealth of Australian expertise remains locked within the walls of our research institutions — leaving us languishing among the world's least effective countries at converting research capital into product innovation.

I would like to thank the Deakin Business School researchers for their devotion and time they spent on analysing large samples of data from the Australian Bureau of Statistics (ABS) that form the evidentiary basis for the findings presented in this White Paper. Their work demonstrates the significant value of Australian governments providing access to reliable and relevant data such as that obtained from the ABS's BLADE environment. It is only through such data sharing that governments can improve their policy inputs and advice.

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Acknowledgements

The authors would like to acknowledge the assistance received from several organisations and individuals. We sincerely thank the Institute of Public Accountants (IPA) for their ongoing support of the IPA-Deakin SME Research Centre, especially the CEO Professor Andrew Conway and Group Executive (Advocacy and Policy) Vicki Stylianou, for providing us with all the opportunities to undertake such research work. We express our deep gratitude and appreciation to the Executive Dean of the Deakin Business School, Professor Mike Ewing, the Head of the Accounting Department, Professor Anne Wyatt, and Associate Dean Research of the Deakin Business School, A/Professor Joshua Newton, for their ongoing support, belief and encouragement of the work the Centre undertakes and for believing in us! We take this opportunity to thank the Australian Bureau of Statistics for providing us with data access to the Business Longitudinal Analysis Data Environment (BLADE). The results presented in this Small Business White Paper would not have been possible without access to such firm-level data. We also express our deep gratitude to Professor Anne Wyatt for her insightful comments on earlier drafts of this White Paper and Tom Ormonde for being able to transform the White Paper into an easily readable and communicable document.

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Executive Summary

Australian politicians have often boasted about the nation's long record of continuous economic growth after the 1990s recession. But behind the headline figures, a much less flattering picture emerges. It tells a story of persistent under-performance by Australia on a fundamental economic indicator – private sector innovation and research. On almost every measure of innovation, Australia's private sector has been performing poorly. Its expenditure on research and development (R&D), for example, has been at or below OECD averages for most of the past two decades. And Australian businesses rank among the least effective in the OECD at introducing product and process innovations.

Economists have long considered innovation and R&D to be primary drivers of national productivity gains and economic growth. The fact that Australia, until the 2020 COVID-19 recession, managed to sustain decades of growth while performing relatively badly on such a fundamental indicator can be put down largely to two factors: booming Chinese demand for our mineral resources and other exports, and high rates of immigration.

But how secure is this economic model? And how long can it be sustained? With pressure to moderate future immigration rates to ease the infrastructure strain on big cities, and amid continuing turmoil in Australia's political and economic relationship with China, the extent to which we can rely so heavily on these two historical growth sources into the future is unclear at best. In short, Australia faces a pressing need to diversify its economic foundations and 'insure' against downturns in key areas on which it has arguably become over-dependent.

Of all the potential ways in which Australia could diversify its sources of economic security, one of the most obvious involves the currently unrealised potential of businesses to innovate and conduct R&D at internationally competitive levels. Evidence detailed in this White Paper paints a sobering picture of mediocre performance and lost opportunities for Australia in these crucial areas. Our research – comprising detailed reviews and statistical analysis of a wide body of local and international data sources – shows Australian industry falling behind much of the developed world on innovation and R&D. And this is inevitably feeding into Australia's perennially poor performance on productivity.

Back in 2015, in our first IPA-Deakin Small Business White Paper, we identified a persisting failure to lift business productivity, or efficiency, as a critical problem for the Australian economy. Evidence presented in this third Small Business White Paper confirms the situation has worsened since then, with our analysis showing the technical efficiency of Australian private companies declined across all industries between 2006 and 2018 (see Figure 9). We believe that a key source of Australia's insipid performance on private sector innovation and efficiency since the start of this century has been the failure of businesses to tap into the strong research culture in the nation's world-class universities and other government-funded research institutions. Recent government-commissioned reviews have highlighted low levels of collaborative interactions between Australian industry and research institutions. In this White Paper, we detail strong evidence pointing to the lack of university-industry collaboration as a key reason for Australia's ranking among the world's least effective countries at converting research capital into product innovation.

We also present a series of recommendations on how some judicious fine tuning of government policies and regulations aimed at encouraging world-class innovation and R&D – particularly in the lagging small and medium-size enterprise (SME) sector – could unlock this potentially rich future source of growth and prosperity, and ultimately help to secure the Australian economy against over-reliance on its currently narrow and potentially unstable foundations.

Background — Australia's R&D Tax Incentive System

The Australian Government's Research & Development Tax Incentive scheme (R&DTI) is the primary mechanism for encouraging Australian companies to engage in R&D.

Under the scheme, launched in 2011, companies can reduce their R&D costs by accessing tax offsets for eligible R&D expenditures. The scheme is jointly administered by the Department of Industry, Science, Energy and Resources and the Australian Taxation Office (ATO), and is intended to be market driven and broadly based across all industries. The scheme is based on dual recognitions that innovation is an important driver of productivity and economic growth, and that business investment in R&D is responsive to tax subsidies.

One of the primary motivations for replacing the former R&D Tax Concession program with the R&D Tax Incentive scheme in 2011 was to improve incentives for smaller companies to undertake R&D. However, as demonstrated in this White Paper, small and medium-size companies continue to face significant obstacles to participation in R&D, with negative consequences both for the companies that fail to realise their innovation potential, and for the broader Australian economy.

Research Methods

Our findings are based primarily on an extensive review and analysis of a large body of published data and statistics relating to research and development activities from Australian and overseas sources. We also conducted an extensive review of previous Australian and overseas academic literature on R&D to inform our research findings.

Key Findings

The Australian R&D Tax Incentive System

- We found strong evidence that Australia's R&D Tax Incentives system not only stimulates R&D investment, but supports increased patent activity. Our analysis shows approximately $1.41 of additional R&D expenditure was invested per dollar of tax revenue foregone under the scheme for a sample of companies between 2012 and 2018.
- Despite the stimulatory effects of our R&D incentives system, Australian businesses – perhaps overly comforted by the previous 'certainty' of high immigration rates and booming sales to China – lag behind much of the developed world on key measures of innovation, research and development.
- Average R&D expenditure for all Australian private companies increased from around $1.24 million in 2004 to a high of $4.18 million in 2014, before declining to $3.58 million in 2018.
- Australia's mean R&D expenditure as a percentage of gross domestic product (GDP) declined from 2.18 per cent in 2010 to just 1.79 per cent in 2017 – well below the OECD average of 2.34 per cent (2000-2017), and way behind high-ranking countries such as Israel (4.94 per cent), South Korea (4.53), Taiwan (3.46), Sweden (3.32), Japan (3.28), Germany (3.13), Denmark (3.03) and the USA (2.83).
- Australia slipped from 18th to 23rd in the Global Innovation Index rankings in the decade to 2020.
- Shortcomings in the existing incentives system are potentially contributing to Australia's under-performance in innovation and R&D. For example, we conclude that the eligibility criteria for R&D activities are too narrow, with the exclusion in particular of software-related research and development arguably hampering the competitiveness of Australia's software industry and denying 'spillover' benefits to the broader economy.
- As business and public research institution R&D spending is predicted to decrease in the post COVID-19 world (due to the economic downturn creating less funding opportunities), it is important for the Federal Government to step in and counteract these declines.

Industry-University Collaboration

- We found strong evidence that collaboration between industry and research organisations enhances research outputs. Yet only 4.14 per cent of private companies in Australia reported collaboration with universities in the 2016-17 ABS Business Characteristics survey. Most of the collaboration that did occur (54 per cent) was conducted by larger entities.
- Small companies (less than $20 million in annual turnover) were 83 per cent less likely to collaborate with universities compared to larger companies.
- Australia ranked a lowly 39th in a 2020 global survey of "university/industry research collaboration".
- R&D incentives, if optimised, *can* provide effective motivation for SMEs to engage in both collaborative and non-collaborative R&D activities.
- A key to improving Australia's future R&D performance will be the development of policies to promote more effective collaboration and commercial utilisation of intellectual capital in universities and other research institutions.

Small Business and R&D

- Small businesses (less than $20 million in annual turnover), despite their significant role in the economy as employers and generators of wealth, account for just 18.2 per cent of total business expenditure on research and development in Australia.

- SMEs often face difficulties finding suitable sources of capital to invest in R&D. This issue can be compounded by the ineffectiveness of capital markets when it comes to financing R&D.
- Changes to Canberra's R&D Tax Incentives scheme commencing on 1 July 2021 – ostensibly intended to reward companies that spend more on R&D – will have the perverse effect of lowering effective incentives for SMEs because of interactions with decreases in SME company tax rates over the next five years. Under the existing system, SMEs are entitled to R&D tax credits of 43.5 per cent. Under the new system, they will get the corporate tax rate of 25 per cent plus 18.5 per cent – which will in effect progressively reduce the benefit to SMEs as slated cuts in the SME corporate tax rate take effect. Hence, while decreases in the corporate tax rate will be supportive for SMEs broadly, they will increase the effective cost to them of engaging in R&D. We believe that eroding the value of the R&DTI for SMEs will disadvantage new, innovative businesses and provide stronger incentives for them to establish R&D operations offshore.

Policy Recommendations

Given evidence supporting the effectiveness of the R&DTI system on R&D expenditures and outcomes, our recommendations focus on enhancements to the system "at its margin", rather than its core, with the potential to materially impact on research activity by SMEs. Based on the findings of our White Paper research team, we recommend that the Australian Government:

1. Reverse its planned cuts to the level of R&D incentives for SMEs (resulting from the benchmarking of the relief rate to corporate taxation rates, which are scheduled to decline in coming years). We recommend reverting to the fixed rate incentive (at 43.5 per cent) for SMEs.
2. Implement quarterly reimbursement of R&D offsets, allowing SMEs to more rapidly reinvest offsets in further R&D expenditures.
3. Introduce a premium to the R&DTI for research conducted in collaboration with Australia's world-class research institutions, enabling the benefits of collaborative research.
4. Commence a policy experiment using innovation vouchers redeemable for collaborative research to:
    - Enhance collaboration between SMEs and researchers
    - Address the funding needs of innovative SMEs
    - Help address the perceived cultural barriers between researchers and industry
5. Increase funding to Collaborative Research Centres (CRCs) and CRC-Projects, improving the infrastructure available to businesses to find appropriate research contacts and to collaborate on short-term or long-term research projects.
6. Expand the definition of eligible research to include more elements of software production, and provide clear guidance to software companies about eligibility.
7. Expand and encourage the use of Advanced Finding to increase certainty among SME applicants and reduce eligibility risk.
8. Increase the use of policy experiments when making amendments to R&DTI policies, releasing data broadly to encourage post-implementation evaluation of the merits of R&D policies.

Research and Development Tax Incentives: Improving Industry-University Collaboration

Introduction

Australia's Chief Scientist, Dr Cathy Foley, recently called on the Federal Government to make science and innovation the "heart" of Australian policy development.[1] In a cautionary presentation, Dr Foley warned that many local innovation opportunities were being under-utilised by Australians and capitalised on by foreign businesses.

There is considerable evidence to support Dr Foley's warning. On a range of measures, Australia's performance in commercial research and innovation has been lagging relative to other countries. Business expenditure on research and development (R&D) has been consistently at or below OECD averages, and Australian businesses rank among the least effective in the OECD at introducing product and process innovations (Australian Government, 2016).

The seriousness and urgency of these issues for Australia's economic future cannot be overstated. For years, Australia has relied on high rates of immigration and booming exports to China to sustain continuous economic growth. Now, amid political pressure over the strains that high population growth places on our big cities, the future of high immigration as a key source of post-COVID economic growth cannot be assured. Turmoil in Australia's political and commercial relationship with China has also highlighted our vulnerability on another primary driver of the economy. Hence, Australia has a pressing need to diversify its sources of economic growth.

An obvious area in which Australia can – and should – diversify its sources of growth and security is in the currently under-done field of research and development. Australia, like most major developed countries, has historically relied on tax incentives as a primary policy instrument to encourage research and innovation in the private sector. But the recent under-performance of Australian businesses in R&D has raised questions about the effectiveness of the existing framework.

Since it became operational in 2011, Australia's R&D Tax Incentives (R&DTI) system has provided the majority of businesses innovation support, delivering over 90 per cent of innovation funding, valued at over $3 billion annually.[2] While widely regarded as an effective mechanism to encourage R&D activity, the optimal settings for the tax incentives are far from settled, with the Government commissioning multiple inquiries in the past decade and implementing substantial and controversial changes in the wake of the COVID-19 pandemic within the Treasury Laws Amendment (A Tax Plan for the COVID-19 Economic Recovery) Bill (2020).

Yet serious questions remain about how well-placed Australia is to lift its game in this important area – and in doing so 'insure' the economy against downturns in other key areas. This makes it particularly apt time for our research team at Deakin Business School, in conjunction with the Institute of Public Accountants, to have undertaken a major project examining the sources and extent of Australian industry's recent lacklustre performance on research and development. Our findings, published for the first time in this White Paper, are based on detailed analysis of data sourced from the OECD and ABS BLADE, as well as comprehensive reviews of previous research in this area. Our analysis focuses particularly on the effects of tax offsets on private company R&D behaviour – including levels of R&D expenditure as well as outcomes such as patents filed and granted. We also examined the effects of R&D tax offsets on collaboration between businesses and researchers. And our analyses include tests related specifically to the effect of incentives on SMEs, given their role as primary drivers of innovation and substantial contributors to the Australian economy.

Our research confirms a bleak picture of opportunities being lost as Australian businesses lag behind much of the developed world on key measures of innovation, research and development.

We make two broad findings. First, we find compelling evidence that shortcomings in the existing R&D incentives system could be contributing to Australia's under-performance in innovation and R&D. Second, consistent with evidence from foreign jurisdictions, our analysis shows that R&D incentives, if strengthened, can provide effective motivation for SMEs to engage in both collaborative and non-collaborative R&D activities. Based on this finding, we believe the focus of debate about innovation policy must now shift further towards the need for more collaborative research – capitalising on the wealth of expertise currently locked within the walls of research institutions.

To this end, we have prepared a series of recommendations in this White Paper aimed at focusing the R&DTI on stimulating collaboration between research organisations and small and medium-sized enterprises (SMEs) — measures that we believe will ultimately help Australian industry to realise its potential to innovate more effectively, compete internationally and generate more employment and prosperity for future generations of Australians.

The focus on R&D incentives

Several factors motivate us to focus on Australia's R&D incentives. The vast majority of Australia's research support comes through the R&DTI, but the scheme is currently the subject of intense political debate. In the October 2020 federal budget, the Government proposed amendments to the R&DTI that affirm its importance to Australia's future economic growth and development of sovereign capability. These changes come off the back of 2019 slated changes that would have removed $1.8 billion[3] in support from Australian R&D – in an effort to cut the cost of the program – and are a response to the impacts of COVID-19 and the need to provide a high level of support to future Australian industries. Despite the Commonwealth government's reversal of the proposed $1.8 billion subsidy cuts from the R&D system, the budget measures have raised a number of concerns held by Australian businesses engaged in research activity. For example, in an open letter to the Government prior to watering down the proposed changes, a consortium of Australian technology businesses called for greater support to Australia's R&D-focused industries, citing far greater levels of support provided by foreign countries.[4] Moreover, there remains uncertainty and concern about the effect of the new rules on the software industry – widely touted as a high-potential growth area for Australian business.

Also of notable concern is that the newly revised R&DTI scheme may not adequately support either (a) the R&D activities of smaller Australian businesses or (b) collaborative research with Australia's world-renowned research institutions. Furthermore, the eligibility criteria for R&D activity are narrow and they do not include software-related research activities and development, which arguably hampers the competitiveness of Australia's software industry. Support for these elements of the R&D landscape is crucial. Government R&D subsidies aim to address market failures by incentivising businesses to conduct additional R&D, in order to address potential underinvestment in R&D in ways that provide positive externalities (spillovers) to the broader economy (PC, 2007; CIE, 2016; Ferris et al., 2016). However, given the financial and other constraints facing smaller Australian businesses, and the absence of policy focused on generating economic spillover benefits from collaborative research (CIE, 2016; ISA, 2016), whether the Australian R&D taxation credit system sufficiently promotes R&D expenditure, particularly among small businesses, is unclear.

Given the above-mentioned concerns regarding the effectiveness of the R&DTI and Australia's innovation performance on the world stage, a review of Australia's approach to collaboration within the context of science, technology and innovation is timely. The socio-economic challenges created by the coronavirus pandemic in 2020 have highlighted the need for Australia to quickly and efficiently harness the knowledge and expertise of various groups in society, particularly those involved in knowledge-based sectors such as universities, research institutions and business communities, simultaneously. While the COVID-19 pandemic has led the Federal Government to set up various emergency business relief packages to minimise harm to the economy, such as the injection of $1 billion for research purposes announced in the federal budget in October 2020, these measures are not directed at specifically supporting small business innovation and start-ups. More importantly, as business and public research institution R&D expenditures are predicted to decrease in the post COVID-19 world due to the economic downturn creating fewer funding opportunities, it is important for the government to step in and counteract these declines in order to avoid a standstill in industries negatively affected by COVID. For example, Universities Australia reports that 17,300 jobs and an estimated $1.8 billion in revenue were lost in the sector in 2020, predicting that a further $2 billion in revenue will be lost in 2021.[5] Accordingly, the White Paper provides an overview of several approaches that can be used to support the research activities of both the SMEs and research institutions that are central to the Australian economy.

Against this background, the White Paper examines the effectiveness and efficiency of the R&D Tax Incentive scheme among private companies in Australia since it became operational in July 2011. The analyses focus on examining the average impact of R&D tax offsets on private company R&D behaviours in the form of innovation inputs such as R&D expenditures and innovation outputs such as patents filed and patents granted as well as the effects of R&D tax offsets on collaboration. The paper begins by providing a brief background on Australia's R&D tax incentive system followed by an overview of how Australia's tax legislation defines research and development as well as R&D activities. This is followed by an examination of the effectiveness of the R&DTI system in relation to the OECD, inhibitions to SME innovation and collaboration and responsiveness of the R&DTI on business investment in R&D. In addition, we examine the effects of innovation inputs such as R&D expenditures on employment and on the efficiency of private companies, and assess the effects of collaboration on innovation outputs such as patents filed and patents granted. The above-mentioned evidence provides us with the means to develop recommendations and provide a conclusion to the White Paper.

Background

Australia's R&D Tax Incentive (R&DTI) system

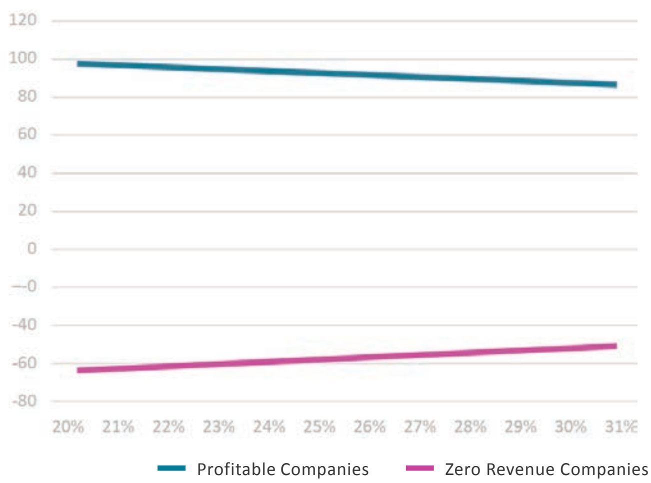
Australia's R&DTI scheme is designed to encourage companies to engage in R&D that benefits Australian society. Under the scheme, companies can reduce their R&D costs by accessing tax offsets for eligible R&D expenditures. The scheme, which is jointly administered by the Department of Industry, Science, Energy and Resources (DISER) (formerly administered by AusIndustry) and the Australian Taxation Office (ATO), is intended to be market driven and broadly based across all industries. DISER and the ATO administer the program under the requirements of Division 355 of the Income Tax Assessment Act 1997 (ITAA 1997) and the Industry Research and Development Act 1986 (IR&D Act 1986).

The stated objectives of the ITAA 1997 and the IR&D Act 1986 are to support and encourage industry to conduct collaborative research and development activities through the provision of a tax incentive "for industry to conduct, in a scientific way, experimental activities for the purpose of generating new knowledge or information" (see Section 355-5(2), ITAA 1997). The R&DTI is based on dual recognitions that innovation is an important driver of productivity and economic growth, and that business investment in R&D is responsive to tax subsidies (Thomson & Skali, 2016). The scheme assumes that effective responsiveness to tax subsidies is achieved only via an incentive scheme designed carefully to both lower the cost of R&D and help boost productivity and economic growth (Mercuri & Birbeck, 2020).

One of the primary motivations for replacing the R&D Tax Concession program introduced in 1986 with the R&D Tax Incentive scheme in 2011 was to improve incentives for smaller companies to undertake R&D. More importantly, the R&DTI decoupled the incentive for R&D activity from the corporate tax rate, which under the Tax Concession program reduced the level of tax concession assistance concomitantly with a decrease in the corporate tax rate. Accordingly, the R&DTI has two core components: a 43.5 per cent refundable tax offset for eligible entities whose aggregated turnover is less than $20m, and a 38.5 per cent non-refundable tax offset for all other eligible entities. Unused offset amounts may be carried forward to future income years. Initially, the Tax Laws Amendment (Research and Development) Act 2011 legislated higher tax offset rates of 45 per cent and 40 per cent respectively. However, amendments to the Act in 2014 reduced the R&D tax offset to the company tax rate for that portion of an organisation's notional R&D deductions that exceed $100 million during an income year.

Forthcoming changes to the R&DTI commencing on 1 July 2021 introduce a variable intensity premium that will enable access to higher R&D tax offsets for larger companies incurring R&D expenditure that is equal to or greater than 2 per cent of the company's total expenditure, whereas the R&D premium for smaller companies (with turnover under $20 million) will change to 18.5 per cent above the corporate tax rate for such companies. While these changes appear to improve the tax incentive scheme by creating greater benefits to companies that devote more resources to R&D, our research demonstrates that these changes will actually lower the benefits of the scheme for SMEs. Where previously tax credits were offered to SMEs at a flat rate of 43.5 per cent, tax credits provided under the planned R&DTI will be fixed at a tax premium rate of 18.5 per cent. However, with corporate tax rate decreases for SMEs slated to take effect in the next five years, the effective cost of engaging in R&D for these companies will increase. Figure 1 demonstrates how SMEs might face increased effective costs. The diagram shows corporate profit relative to the headline tax rate, with corporate profit partitioned between profitable SMEs (we assign revenue of $200 and R&D expenses of $100) and SMEs without revenue but with access to refundable offsets. As the headline tax rate declines, profitable companies experience improvements in corporate profits, as revenues earned by the company benefit from reduced taxes. However, companies without revenue experience declines in profit and cash flow (relative to higher tax rates) as reimbursements from R&D tax offsets decline with the tax rate. Accordingly, reductions to the corporate tax rate reduce the incentives for low revenue, early-stage companies to invest in R&D.

Figure 1 — Corporate Profit vs. Taxation Rate



Source: IPA-Deakin Centre Analysis

RESEARCH AND DEVELOPMENT TAX INCENTIVES: IMPROVING INDUSTRY-UNIVERSITY COLLABORATION

Definition of R&D and R&D activities

The OECD's Frascati Manual (2015)[6] is widely accepted internationally for its R&D definitions and its concomitant classifications of R&D activities. The definition of R&D and the types of research activities outlined in the ITAA 1997 fundamentally mirror the principles embedded in the Frascati Manual (Mercuri & Birbeck, 2020; Ferris et al., 2016). Australian legislation draws on the OECD's definition, which states that "Research and experimental development (R&D) comprise creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge" (OECD, 2015, p. 44). In recognition of the broader underlying principles embedded in the OECD's definition of R&D, the explanatory memorandum to the Tax Laws Amendment (Research and Development) Bill 2010 acknowledges the private sector benefits of conducting R&D to society (see Paragraph 1.9).

Australian legislation, though influenced by the OECD's definition of R&D, has a heavy focus on determining the types and definitions of research activities that comprise R&D. Drawing on the Frascati Manual, R&D activities are identified by a set of five common features, or core criteria. To qualify as R&D, the activity must be novel, creative, uncertain, systematic and transferable and/or reproducible (OECD, 2015, p. 45). The term R&D covers three types of research activities: basic, applied and experimental. In broad terms, basic research is experimental or theoretical in nature and is undertaken primarily to acquire new knowledge. This type of research also does not necessarily require any particular contemporary application or use. Applied research is original in nature – being undertaken to acquire new knowledge – but is directed primarily towards a specific, practical aim or objective. Experimental development, by contrast, is defined as systematic work that draws on existing knowledge gained from research and practical experience to produce additional knowledge. This type of research is primarily directed at producing new products or processes or at improving existing products or processes (OECD, 2015, p. 45).

The concept of 'experimental development', however, should not be confused with 'product development', which is the overall process from formulation of ideas and concepts to commercialisation aimed at bringing a new product (good or service) to the market (OECD, 2015, p. 51). According to the Frascati Manual, experimental development involves testing generic knowledge for a specific application, and is therefore just one possible stage in the product development process (p.51).

Australian tax legislation such as the R&DTI and the Australian Taxation Office (ATO) adopt a strict approach to defining eligible R&D activities, relying heavily on the concepts of experimental research and the core criterion of novelty. We argue in the White Paper that such an approach adversely limits the scope of the R&DTI, and potentially denies the economy wider 'spillover' benefits when certain viable commercial innovation ventures, such as some software developments, are ruled ineligible. While we agree with the general approach of making routine software-related activities ineligible, we argue that some software development should be considered eligible R&D activity, and that these activities are likely to become a vital part of the Australian economy in the future. The Frascati Manual says several types of software development activities should qualify as R&D, including activities that aim to systematically resolve a scientific and/or technological uncertainty, activities dependent upon a scientific and/or technological advance for their completion, and activities for where the R&D associated with software as the end product is also classified as R&D. We agree with the Frascati Manual's stance. Accordingly, we recommend that the R&DTI be amended to (a) explicitly broaden the scope of eligible R&D activity to include software-related research activities; and (b) provide clear advice on the requirements for software developers to comply with the requirements of the R&DTI.

The effectiveness of Australia's R&DTI system

Our review of recent research and commentary related to the R&DTI shows evidence that the scheme is succeeding in promoting R&D among certain entities – primarily, larger businesses. However, calls for greater assistance to small businesses undertaking R&D and increasing collaborative research with Australia's world-renowned research institutions is warranted.

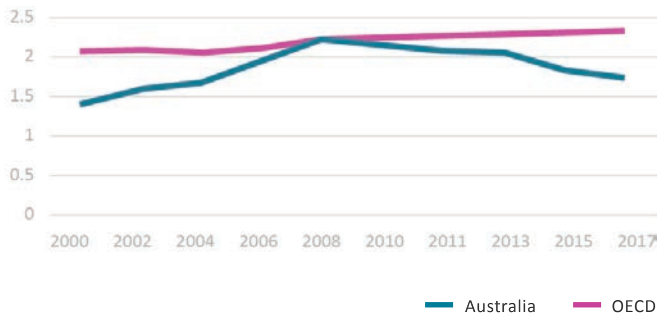
The concerns are borne out in evidence presented to the Senate Economics Reference Committee in 2018, showing that average R&D expenditure for all Australian listed companies declined from a high of $22 million in the early 1980s to a low of just $4 million in 2004, before increasing to $10 million in 2018 (Akhtar, 2018). A similar trend is observed among Australian private companies. Analyses conducted on the ABS' Business Longitudinal Analysis Data Environment (BLADE) by the White Paper research team reveals that average R&D expenditure for all Australian private companies increased from around $1.24 million in 2004 to a high of $4.18 million in 2014, before declining to $3.58 million in 2018. Furthermore, Australia's mean R&D expenditure as a percentage of gross domestic product (GDP) declined by 40 points from 2.18 per cent in 2010 to 1.79 per cent in 2017, and is significantly lower compared to average OECD member country levels of 2.34 per cent over an 18-year period between 2000 and 2017 (see Figure 2).

Reviews conducted by the Productivity Commission (2007) and the Centre for International Economics (CIE) (2016) also find little evidence of spillover effects from R&D in Australia. Evidence also suggests that Australian R&D is conducted largely without collaboration between industry and research providers (Australian Government, 2016), with Australia ranking poorly compared to OECD peers. More recent OECD (2017) data confirms that Australia has one of the lowest rates of collaboration on innovation[7] between private businesses and universities (including research institutions) compared to other OECD member countries.[8] Australia also ranks relatively poorly compared to OECD peers on both aggregate business R&D activity (BERD) and growth in that activity (see Appendix - Tables A2 and A4).

Other evidence also supports these conclusions. The Global Innovation Index (GII) shows that over the past 10 years, Australia has slipped in global innovation rankings by five places, from 18th in 2009-10 to 23rd in 2020. A review of the seven innovation pillars[9] measured in the GII shows that Australia is underperforming in the area of "knowledge and technology outputs" (Cornell University, INSEAD, and WIPO, 2020), ranking 40th out of 131 countries surveyed in 2020, and 39th on the measure of "university/industry research collaboration". Further, Australia's patent output as a percentage of GDP is low in comparison to the top 10 GII ranked countries in 2020 (see Figure 3).

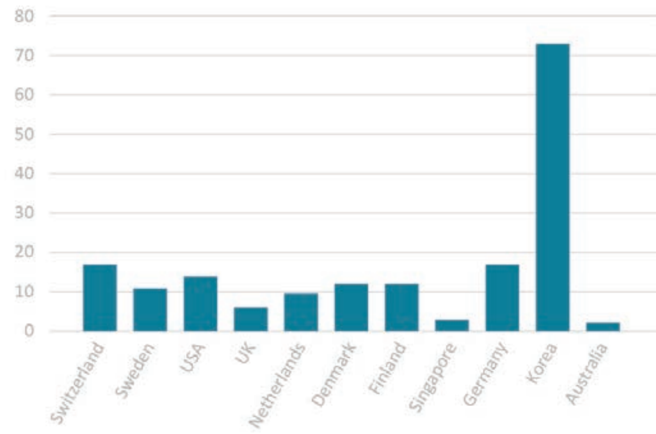
Data on triadic patent filings compiled by the OECD also shows Australia lagging behind other countries. Triadic patent families are sets of patents filed in different patent offices around the world to comprehensively protect the same innovation. Table 1 shows successful filing of triadic patent families by country, benchmarked to the year 2000. This data is presented for Australia and the other countries shown previously in Figure 3. It shows that in 2018, the number of triadic patents filed by Australia was just 71.6% of the number filed in 2000, although Australia's performance has increased since the introduction of refundable credits in 2011. The overall decline in Australia's performance on this measure also compares poorly against other countries, with only Germany and Finland having larger decreases in filings. Neighbouring economy New Zealand, by comparison, suffered a relatively modest 8 per cent decline in patent numbers.

Figure 2 — R&D expenditure as a percentage of GDP



Source: OECD (2018)

Figure 3 — Comparison of Australia's patent output as a percentage of GDP with top 10 GII Countries



Source: Cornell University, INSEAD, and WIPO (2020)

Table 1 — Number of triadic patent families by country: 2010-2018

Year	AUS	CHE	DEU	DNK	FIN	GBR	KOR	NLD	NZL	SGP	SWE	USA
2000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2001	0.898	0.980	0.947	0.969	0.960	0.970	1.270	1.080	0.804	1.421	0.951	1.018
2002	0.950	0.986	0.901	0.992	0.733	0.942	1.727	1.476	1.129	1.540	1.002	1.052
2003	0.961	1.037	0.883	1.077	0.809	0.932	2.415	1.573	1.061	1.613	0.955	1.072
2004	1.006	1.092	0.916	1.271	0.912	0.888	2.829	1.563	1.101	2.241	1.017	1.101
2005	0.927	1.079	0.935	1.345	0.903	0.917	3.021	1.394	1.015	2.054	1.223	1.112
2006	0.701	1.145	0.856	1.098	0.683	0.887	2.582	1.168	0.986	1.765	1.116	0.990
2007	0.673	1.005	0.760	1.093	0.599	0.764	2.176	0.840	0.783	1.407	1.212	0.888
2008	0.612	0.989	0.717	1.184	0.584	0.717	2.012	0.892	1.010	1.392	1.054	0.886
2009	0.679	0.968	0.727	0.888	0.513	0.730	2.320	0.828	0.762	1.248	0.998	0.864
2010	0.595	1.059	0.662	1.039	0.524	0.703	2.705	0.654	0.618	1.309	0.810	0.817
2011	0.621	1.056	0.632	0.892	0.525	0.732	2.603	0.767	0.721	1.455	0.776	0.846
2012	0.653	1.138	0.601	0.979	0.668	0.721	2.744	0.823	1.450	1.292	0.836	0.880
2013	0.598	1.112	0.643	0.912	0.625	0.773	2.804	0.901	0.979	1.565	0.742	0.948
2014	0.627	1.174	0.609	1.059	0.722	0.709	2.432	1.019	1.393	1.786	0.852	0.874
2015	0.665	1.193	0.612	1.092	0.610	0.697	2.441	0.883	0.937	1.460	0.905	0.867
2016	0.684	1.226	0.615	1.103	0.605	0.707	2.395	0.899	0.901	1.409	0.901	0.824
2017	0.711	1.251	0.620	1.138	0.605	0.715	2.313	0.867	0.912	1.455	0.936	0.817
2018	0.716	1.268	0.625	1.163	0.614	0.726	2.376	0.863	0.919	1.443	0.975	0.816

Source: OECD Data Repository (OECD.Stat)

Barriers to SME R&D and collaboration

The recent reviews of the innovation system suggest that Australia's underperformance can be linked to several economic, social, and cultural factors that impede both R&D activity and, specifically, collaboration between industry and researchers. On collaboration, the evidence from these reviews suggests that strong differences in culture and differing expectations affect the willingness of both parties to engage in common projects (CIE, 2016). It is suggested that these differences arise primarily from conflicting incentives for academic researchers and industry (Cunningham and Gok, 2012), coupled with diverse backgrounds of experience, culture and training that inhibit alignment. Criticism has also been levelled at incentives and promotional opportunities in universities, which are rarely tied to performance in patent applications, intellectual property licensing or collaboration agreements (OECD, 2012; 2017).

A recent survey of companies by the ABS also suggests additional issues impacting on collaboration (Table 2). Among those surveyed, small companies with few employees cited insufficient time (akin to resources) and insufficient funds as primary reasons limiting collaboration on R&D (approximately 20 per cent of respondents cited both reasons). These reasons were less frequently cited by larger companies. In contrast to the findings of the CIE (2016) – which suggests that cultural factors are a primary reason for limited collaboration – the ABS data suggests that SMEs are deterred from collaboration by the costs. Accordingly, it is clear that government support for collaboration should address both cost barriers and cultural impediments. While cultural impediments are likely to be more important factors in larger businesses, cultural impediments were rarely cited in SME company responses — except so far that limited exposure to academics impedes industry from identifying relevant researchers with whom to collaborate.

The review by Innovation and Science Australia (ISA) (2016) provides evidence that Australia also lacks government investment in knowledge-sharing centres and infrastructure, adding to the difficulty of finding relevant researchers with whom to collaborate. The reported lack of investment in knowledge-sharing infrastructure also compounds skills shortages seen throughout industry (CIE, 2016). Table 3 shows data related to skills shortages in companies performing R&D. The shortages vary considerably by industry and by company size. Among smaller companies, skills shortages are most common in business-related fields such as the trades, transport and machinery operation and business management. Among larger companies, skills shortages are common in technical fields such as engineering, science, information technology and finance. With both limited experience in finding research partners, and no centralised location to seek research partners, companies are required to navigate sometimes complex university or research-centre collaboration requirements (EC, 2007). The complexity of these arrangements further limits collaboration.

Table 2 — Reasons for not collaborating on innovation activity

	0-4 persons	5-19 persons	20-199 persons	>200 persons	Total
	%	%	%	%	%
Company Reasons					
No expected benefit	11	8.8	9.8	9.1	10
Unable to find a suitable collaboration partner	8.3	6.2	5.6	6.3	7.2
Lack of access to knowledge or advice about collaborative arrangements	6.4	4.9	4.6	4.9	5.6
Lack of skills within the business	4.9	4.2	7	6.4	4.8
Insufficient time	19.7	20	14.5	13.5	19.3
Insufficient funds	22	19.1	14.6	10	20.1
Government regulations or compliance	4.8	4.1	4.5	10.1	4.6
Reasons relating to collaboration partner(s):					
Differences in priorities or outcomes sought	2.4	1.7	2.9	2.5	2.2
Different work practices	1.8	1.6	1.5	2.1	1.7
Confidentiality or trust concerns	3.2	2.4	3	4	2.9
No factors	56.1	59.8	63.2	66.2	58.3

Source: Australian Bureau of Statistics. Ppx indicates for persons employed

Table 3 — Skills shortages in private companies conducting R&D by size of business

Skills shortage or deficiency to develop or implement innovation	Small % (< $20m turnover)	Large % (≥ $20m turnover)
Engineering	35.46	64.54
Scientific and research	43.04	56.96
Information technology	40.83	59.17
Trades	60.03	39.97
Transport, plant and machinery operation	60.55	39.45
Marketing	65.29	34.71
Project management	33.33	66.67
Business management	55.36	44.64
Financial	39.72	60.28
None of the above	56.78	43.22

Source: ABS BLADE Integrated Data: 2012-2018

International tax incentives

Tax incentive features vary widely between countries.[10] Most countries provide relief using tax offsets or deductions, with eligibility, magnitude of incentives, collaboration incentives and limits or caps all critical features. Some, such as Israel, provide incentives through IP boxes or institutional settings with reduced corporate tax rates, increasing the profitability of investment in certain industries.[11]

Most countries, including Australia, provide tax offsets to incentivise R&D, but with some variations between them. In Australia, eligible research activities must relate to experimental activities and must resolve a question for which the outcome "cannot be known or determined in advance on the basis of current knowledge, information or experience" through the application of systematic research activities. Other countries – including the United States, United Kingdom and most of Europe – share a similar requirement, although with varying criteria on strength of novelty. More significant differences exist between countries on eligible deductible costs. In Australia, eligible costs include expenditures on wages and salaries, materials, and depreciation of capital assets (including software) used in the research process. Expenditure related to external consulting can be claimed to the extent that it relates to wages and salaries. In the UK, the Research and Development Expenditure Credit (RDEC), and the parallel SME scheme allow for the deduction of intangible asset amortisation. Also, the UK Research and Development Allowance (RDA) permits the deduction of capital spending fully in the year of expenditure,[12] as does the Korean system, which includes capital expenditures among a complex mix of incentive deductions. In contrast, countries such as Canada do not allow for the deduction of capital or intangible expenditures, depreciation or amortisation.

The majority of comparable OECD countries implement volume-based incentives that provide relief based on the level of eligible R&D expenditure. Countries with volume incentives include Australia, New Zealand, the United Kingdom, Korea (which also has incremental incentives), France, the Netherlands, Ireland and many others. Fewer countries use incremental incentives, which are arguably better aligned to the additionality objective of R&D funding. Economically significant and innovative countries using incremental schemes include the United States and South Korea. The US primarily provides relief through the mutually exclusive regular research credit (RRC) and alternative simplified credit (ASC), or through the credit for basic research (CBR) and the energy research credit. The RRC and the ASC have benchmark levels that R&D must exceed to be eligible for credit based on expected or prior R&D cost levels.[13]

The magnitude of relief available to Australian businesses is similar to that available in other counties. As shown in Table A1 (see Appendix A), according to the B-index, Australia ranks 16th and 23rd in the OECD for incentives provided to profit-making and loss-making companies respectively. France, Canada, the Netherlands and the UK all provide stronger incentives to SMEs. France, the most supportive country for SMEs, provides over twice the level of relief as Australia, in additional to tax benefits for companies qualifying under the *Jeune Entreprise Universitaire (JEU)* program, which targets researcher-lead young companies. Australia is the only country in our sample to use an intensity premium, although several countries, such as Israel, vary the strength of incentives for economic impact.

We also find few examples of explicit collaboration premiums among OECD countries. France alone provides for collaboration incentives through the *JEU*. These incentives specifically target the hiring of doctoral students and graduates with double relief from taxation. Australia and New Zealand provide incentives for collaboration through eligibility for small research projects, with small projects ineligible for relief unless conducted in collaboration with approved institutions. These minimum thresholds are rarely found elsewhere in the world.

Non-offset systems focus on relief through reduced tax rates rather than offsets. In Table 5, we provide three examples of such systems. Israel operates at least four such schemes focused on innovative companies. Incentives are provided to Preferred and Special Preferred companies, which benefit from considerably lower tax rates than other companies. Special Preferred companies achieve tax rates approximately one-third the standard corporate rate. France's special tax regime for researcher-focused young SMEs removes 50-100 per cent of corporate tax (depending on the company), and reduces a range of other taxes. Singapore operates the Intellectual Property Development Incentive program to provide incentives to research-focused companies with a 5-10 percentage point reduction in tax rates.

RESEARCH AND DEVELOPMENT TAX INCENTIVES: IMPROVING INDUSTRY-UNIVERSITY COLLABORATION

Table 4 — R&D tax incentive schemes for sample countries

		Eligibility		Incentive			
Country	Scheme/Legislation	Entities	Eligible Costs	Type	Large Bus. Rate	SME Rate	Intensity Premium
Credit/Deduction Schemes							
Australia	R&D Tax Offsets	Companies	W&S, OC, Dep	Volume	38.50%	43.50%	No
Australia	R&D Tax Offsets (Post 2020)	Companies	W&S, OC, Dep	Volume	8.5% - 16.5%	18.50%	Large Entities
New Zealand	R&D Tax Credit	All	W&S, OC, Dep	Volume	15%	15%	No
United Kingdom *	RDEC/SME Relief	Companies	W&S, OC, Intangibles	Volume	14%	44%	No
United Kingdom **	RDAs	Companies	Capital Investment	Volume	19%	19%	
United States	Multiple Schemes	Companies	W&S, C	Incremental	14-20%****	14-20%****	No
Canada***	SRED	All	W&S, OC	Volume	15%	35%	No
South Korea	R&D Tax Credit	Companies	W&S, C	Volume/ Incremental	1-8%*****	25%%	No
South Korea	R&D Investment Credit	Companies	Capital Investment	Volume	1-3%	7%	No
Netherlands	Wet Bevordering Speur- & Ontwikkelingswerk	All	W&S, Capital Investment, Intangibles	Volume^	32%	32%^^	No
France	Crédit d'Impôt Recherche	Companies	W&S, C, Dep, Innovation Activities	Volume	30%	30%	No
Singapore	Enhanced R&D Deduction	Companies	W&S, C	Enhanced Deduction	250%@	250%@	No
Singapore	Enhanced R&D Deduction	Companies	Capital Investment	Accelerated Depreciation			
Preferred Taxation Schemes							
Israel	Preferred Enterprise	Industrial, royalty-driven		7.5% - 16%			
	Special Preferred Enterprise	Large, multinational		5 - 8%			
	Preferred Technology Enterprise	Technology		7.5% - 12%			
	Special Preferred Technology Enterprise	Technology		6%			
France	Jeune Entreprise Universitaire##	Research-focused companies		50-100% reduction in corporate tax, reductions in holding taxes and fees, reductions in tax on sale of share holdings by researchers.			
Singapore	Intellectual Property Development Incentive	Research-focused companies		5-10% reduction in tax rate			

Collaboration		Features		
Collab. Premium	Min w/o PFRO	Refundable	Refund Cap	Incentive Cap
No	A$20,000	Loss SMEs	Yes	$100m
No	A$20,000	Loss SMEs	Yes	$150m
No	NZ$50,000	Loss SMEs	NZ$0.255m	NZ$120m
No	-	Loss-making	No	No
No	-	Startups	US$0.250m	Income based
No	No	CCPCs, Proprietorships	Yes	No
No	No	No	No	No
No	No	No	No	No
No	No	No	No	EUR 0.350m ^^^
Yes##	No	Yes#	Yes	EUR 100m^^^^
No	No	No	No	No

Data: OECD (2020); EY (2020); PwC (2021)
Respective Government Taxation Office Sources

* The 44 per cent SME Rate is based on the level of deduction per pound of spending on R&D as the SME scheme provides allowances rather than tax credits.

** The UK operates parallel schemes for R&D deductions. The RDA scheme is specific for capital investments, and provides for 10 per cent deductibility in the first year of the capital assets life.

*** For the purposes of the SME qualification, Canadian-controlled private corporations are included. These companies must be privately owned by Canadian citizens and therefore likely reflect SMEs. There is a cap on priority rates of C$3 million.

**** This rate is based on the incremental volume, rather than the gross volume.

***** The South Korean system provides both an incremental and volume system. The values presented reflect the volume-based system. Incremental reimbursements range between 25-50 per cent. Incremental reimbursements are incremental to 50 per cent of spending in the previous year.

^ The incentive is offset against the substantial payroll tax liabilities required of Netherlands businesses.

^^ The rate for startup businesses can increase to 40 per cent (OECD, 2020).

^^^ After EUR 350,000, the value of the incentive reduces to 16 per cent. Maximum claimable amount is the payroll tax liability.

^^^^ After EUR 100 million in claims, the incentive rate reduces to 5 per cent. R&D outsourced is capped at 10 million (outsourced to research institutions is capped at 12 million). A variety of caps on other costs also exist.

Credits are refundable for all companies. For large businesses, the credits can be offset against other taxes for three years, with excess credits returned after three years. For SMEs, refunds are immediate, and are uncapped for startup businesses.

Salaries and wages of PhD trained staff are included "twice" for deduction purposes during the first 24 months of the contract period provided they receive ongoing employment.

The Jeune Entreprise Universitaire is available to young (< 8 years), innovative companies owned and operated by researchers, masters or PhD students or graduates or other university-aligned staff and students.

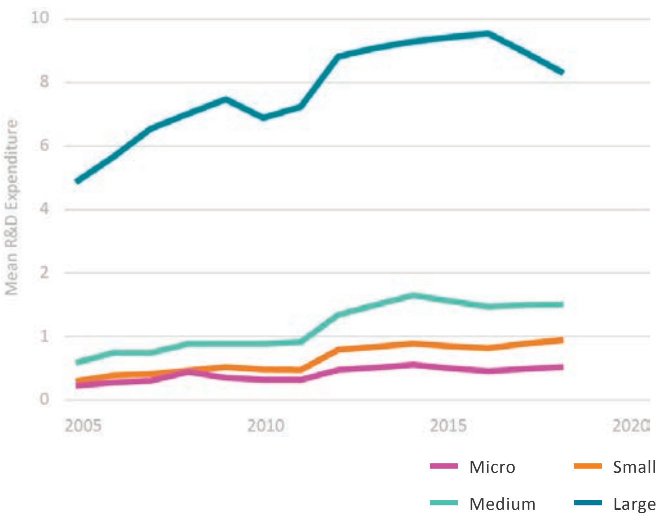
@ The 250 per cent Enhanced distribution translates to 42.5 per cent when viewed as a volume-based offset. The base taxation rate in Singapore is 17 per cent.

Empirical analyses

Data on R&D and collaboration

Our analysis of data provided by ABS BLADE yields several revealing insights. Our examination of private company research data categorised by R&D expenditure and firm size (using number of employees as the size criterion) reveals that average R&D expenditure for large private companies (200+ employees) in Australia was around $6.28 million in 2005, increasing to a high of $10.54 million in 2016, before declining to $9.40 million in 2018. In comparison, medium (20 to 199 employees), small (5 to 19 employees) and micro (fewer than 5 employees) company average R&D expenditures all followed a similar trend, but the quantum amounts of R&D expenditures for these companies are significantly smaller compared to large companies over the years 2005 to 2018 (see Figure 4). Indeed, 37.3 per cent of R&D-active companies are small (including micro businesses) and around 78.6 per cent of the total number of tax offsets granted are provided to small businesses. But small business account for only 18.2 per cent of total business expenditure on research and development.

Figure 4 — Average R&D expenditure by company size and year in Australia: 2005-2018



Source: ABS BLADE Integrated Data: 2005-2018

The mean value of refundable R&D tax offsets for all small private companies, which attracts a 43.5 per cent refundable tax offset during the tax incentive period (2012 to 2018), was $226,114 (see Table 5). Using number of employees as the size criterion, the average value of refundable R&D tax offsets for micro and small companies was $173,824, while the value for medium size companies was $387,838 – more than double the amount for micro and small companies.

Under the R&D Tax Incentive scheme, entities may carry forward unused offset amounts to future income years. The value of the 38.5 per cent non-refundable tax offset for all eligible entities between 2012 and 2018 was $933,651 (see Table 6). Using number of employees rather than revenue (<$20m) as the size criterion, the average value of non-refundable R&D tax offsets for micro and small companies was $189,349, while the value for medium-sized companies was $425,436 and for large companies over $2.9 million.

Data on collaboration exhibits several concerning features. An examination of the ABS Business Characteristics survey for 2016-17 shows that only 4.14 per cent of private companies in Australia reported collaboration with universities (see Table 7), with most of the collaboration (54 per cent) conducted by larger entities. This statistic provides corroborating evidence to OECD data that shows Australia has one of the lowest rates of collaboration on innovation between private businesses and universities when compared to other OECD member countries.

Further analyses of the 4.14 per cent of private companies involved in collaboration with universities reveals that small companies (less than $20 million in turnover) are 83 per cent less likely to collaborate with universities compared to larger companies. Those companies that did collaborate with universities had an average R&D expenditure of more than $47 million between 2012 and 2018, receiving $772,106 in refundable tax offsets and nearly $10.9 million in non-refundable tax offsets carried forward to future income years (Table 8). Companies involved in collaboration with universities are associated with a three per cent greater likelihood of being granted a patent within one-year, increasing to 11.4 per cent in five years, compared to companies that actively conducted R&D without collaboration. These data underscore the urgent need to address the issue of collaboration and to propose recommendations that would assist the tax incentive system meet its policy intentions under the R&DTI legislation.

Table 5 — Average value of refundable R&D tax offsets for Australian private companies by size: 2012-2018

Company Size — Revenue	N	Mean	Median	SD	p25	p75
Small (<$20m)	49,472	$226,114	$116,566	$391,830	$53,064	$248,097
Company Size — Employees	**N**	**Mean**	**Median**	**SD**	**p25**	**p75**
Micro (1-4)	16,965	$122,283	$65,013	$221,645	$31,890	$130,462
Small (5-19)	22,828	$225,364	$130,650	$382,113	$63,344	$251,997
Medium (20-199)	13,065	$387,838	$207,384	$689,672	$97,799	$427,327
Large (200+)	183	$792,555	$283,210	$2,540,634	$76,836	$558,994
Total	53,041	$382,010				

Source: ABS BLADE Integrated Data: 2012-2018

Table 6 — Average Value of non-refundable R&D tax offsets for Australian private companies by size: 2012-2018

Company Size — Revenue	N	Mean	Median	SD	p25	p75
Large (≥$20m)	15,467	$1,703,125	$405,570	$6,154,874	$129,133	$1,179,282
Company Size — Employees	**N**	**Mean**	**Median**	**SD**	**p25**	**p75**
Micro (1-4)	2,066	$197,799	$6,807	$1,691,719	$1,694	$41,486
Small (5-19)	3,246	$180,898	$73,301	$460,687	$19,385	$179,639
Medium (20-199)	11,845	$425,436	$162,742	$908,879	$56,923	$438,730
Large (200+)	7,249	$2,907,659	$724,864	$8,692,518	$240,942	$2,163,406
Total	24,406	$927,948				

Source: ABS BLADE Integrated Data: 2012-2018

Table 7 — Frequency count of Australian companies collaborating with universities and research institutions

	Frequency	Per cent	Cum.
No	7,937	95.86	95.86
Yes	343	4.14	100.00
Total	8,280	100.00	

	No		Yes	
	Frequency	Per cent	Frequency	Per cent
Small (<$20m turnover)	2,999	47.36	128	46.04
Large (≥$20m turnover)	3,333	52.64	150	53.96
Total	6,332	100.00	278	100.00

Source: ABS BLADE Integrated Data: 2012-2018

Table 8 — Average value of R&D expenditure and refundable and non-refundable R&D tax offsets for private companies by collaboration with Australian universities: 2012-2018

	N	Mean Value R&D Expenditure	N	Mean Value Refundable Tax Offsets	N	Mean Value Non-Refundable Tax Offsets
No	283	$20,282,780	68	$324,783	441	$5,211,804
Yes	56	$47,229,144	15	$772,106	57	$10,885,557

Source: ABS BLADE Integrated Data: 2012-2018

RESEARCH AND DEVELOPMENT TAX INCENTIVES: IMPROVING INDUSTRY-UNIVERSITY COLLABORATION

Impact of Australia's R&D tax incentives on business investment in R&D

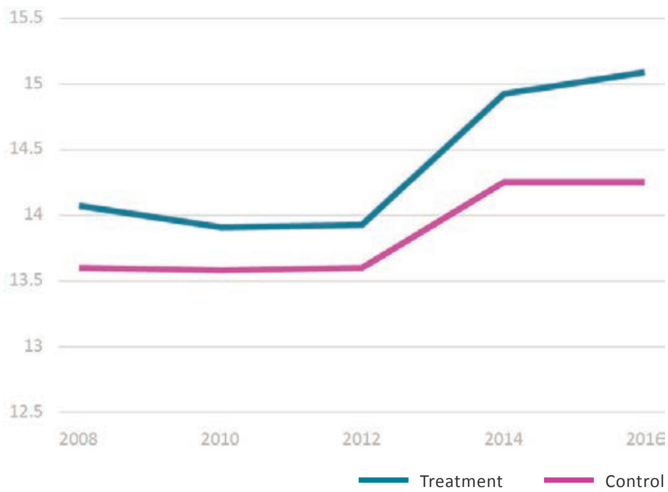
As private sector innovation is the cornerstone of economic progress (Schumpeter, 1934), most OECD countries dedicate significant resources to supporting private sector R&D investment via policy instruments such as either direct subsidies or tax incentives. Australia is no exception, having historically used R&D tax incentives as a means of stimulating private sector investment, in recognition that such investment is not only associated with economic benefits, such as employment growth, but also with a social benefits and spillovers. However, the usefulness of either direct subsidies or tax incentives as policy instruments has been subject of some debate. While a number of empirical studies demonstrate that direct subsidies (Czarnitzki & Licht, 2006) and/or tax incentives provide some additionality to the economy (Thomson & Skali, 2016; Czarnitzki & Licht, 2006; Hall, 2002; David et al., 2000), some economists maintain that government-supported R&D programs crowd out private R&D funding – that is, companies substitute their private R&D investments with public R&D funding (Hall & van Reenen, 2000) and that such subsidies can be dissipated in higher wages instead of stimulating real private sector R&D spending.

As there is limited evidence on the impact of the R&D Tax Incentive scheme introduced in July 2011 on Australian private business investment in R&D, especially on small business investment, we conducted an additionality analysis on the effectiveness of this policy instrument in relation to the small business sector. The term *additionality* essentially refers to whether a government policy intervention such as R&D tax subsidies induces an effect on private business investment compared to a baseline level. In this case, we examined whether the R&DTI tax offsets introduced in 2011 have induced increases in private business spending in R&D by more than the amount of tax subsidies businesses receive from government in support of R&D. In other words, additionality is defined in the White Paper as the additional R&D per dollar of tax forgone on private company R&D investment (see Thomson & Skali, 2016, p. 6-7).

Thomson and Skali (2016) investigated the effects of Australia's tax incentive scheme on companies' R&D expenditures by examining input additionality differences between the Tax Concession and the R&DTI periods for almost the entire population of R&D-active companies between 2005 and 2012, but due to data limitations their study was unable to draw specific inferences related to the small business sector after the introduction of the R&DTI in 2011. The analysis presented in this White Paper builds on Thomson and Skali's (2016) study by examining the same input financial additionality question, but we analyse additionality for the small business sector during the R&D Tax Incentive period between 2012 and 2018, thereby providing a better understanding of the extent to which a given amount of tax subsidies leads to an increase in a small company's R&D expenditures. More importantly, our research not only estimates input financial additionality; we also estimate output additionality and determine the extent to which a given increase in a company's R&D expenditures generated by tax subsidies leads to an increase in the company's patent output measured by number of patents filed and patents granted.

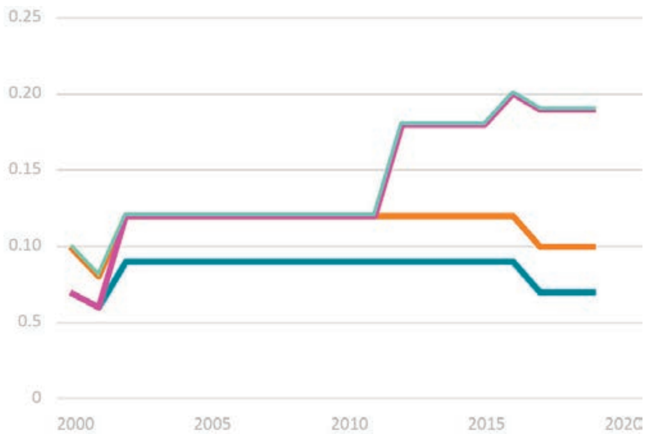
Following Thomson and Skali (2016), we compare R&D expenditures on companies that both actively undertake R&D and claim R&D subsidies (the treatment group) with a sample of propensity score matched companies that actively undertake R&D via R&D expenditures, but do not claim any R&D subsidies (the control or counterfactual group). The matching procedure provides a more reliable assessment of the impact of the R&DTI tax offset on the company's R&D expenditure for two reasons. First, as companies that are R&D-active and claim R&D subsidies are non-randomly selected into the "treatment group", the matching procedure provides a better estimate of the effect of tax offsets on R&D expenditures of companies in the "treatment group" in comparison to the "counterfactual group". Second, to the extent that they are correlated with observed factors, the matching procedure minimises the effect of unobserved factors on a company's R&D investment decision while it is R&D-active and claiming a tax offset compared to the counterfactual group. The propensity score (PS) algorithm procedure matched companies within its industry and PS scores were computed on the following observed characteristics: sales turnover, wages expenditure, and benefits received from other government grants. Results show that of the 9,177 company-year observations identified as actively conducting R&D in between 2012 and 2018, approximately 26 per cent of these companies did not claim the R&D tax incentives. For the 76 per cent of companies that

Figure 5 — Difference in R&D expenditures between R&D-active companies claiming tax offset (treatment group) and R&D-active companies not claiming tax offset (counterfactual group)



Source: ABS BLADE Integrated Data: 2005-2018

Figure 6 — B-Index for Australian R&DTI: 2000-2018



Source: OECD Data Repository (OECD.Stat)

actively undertook R&D and claimed R&D subsidies, our analyses show these companies invest 34 per cent more in R&D in the years 2012 to 2014 and 51 per cent more in 2016-2018, compared to companies that actively conducted R&D, but did not claim R&D subsidies. Figure 5 provides a summary of the differences in R&D expenditures between R&D-active companies claiming a tax offset compared with R&D-active companies not claiming a tax offset.

The average increase in R&D investment by R&D-active companies since the introduction of the R&DTI in 2011 is around 42 per cent. The above-mentioned average increases in R&D expenditures provide an estimate of the impact of the R&DTI scheme to be approximately $1.25 of additional R&D invested per dollar of tax revenue foregone for the sample of companies between 2012 and 2014, whereas during the period 2014-2018 the impact of the R&DTI is about $1.58 of additional R&D invested per dollar of tax revenue foregone. The estimated impact of the scheme over the entire 2012 to 2018 period suggests an additionality of around $1.41. More importantly, additional analyses of R&D expenditures reveal small R&D-active companies claiming a tax offset between 2012 and 2018 increased their R&D spending by around 31 per cent, while small companies claiming a tax offset after the introduction of the $100 million R&D expenditure threshold in 2014 increased their R&D spending by around 51 per cent. These expenditure increases provide an estimate of the impact of the R&DTI scheme on small companies (less than $20 million in revenue) to be around $1.29 of additional R&D invested per dollar of tax revenue foregone over the sample period from 2012 to 2018 and $1.13 for the years 2012-2014, while for the years 2014-2018 the estimated impact of the scheme is $1.47.

As discussed earlier, our analysis of the integrated BLADE and intellectual property (IPLORD) data shows a 14.3 per cent increase in the number of patents for Australian protection filed by private companies in Australia between 2002 and 2017 (see Table 9). During the Tax Concession period (2002 to 2011), the number of such patents filed increased by 2.3 per cent, whereas during the R&DTI period (2012 to 2017) the number of patents filed increased by 5.8 per cent. The proportionate number of patents granted by the Australian patent office also increased by 40.4 per cent over the same 16-year period, with the Tax Concession period showing a 27.7 per cent increase and the R&DTI period showing a 2.9 per cent increase. Private companies held 8,883 live patents in 2002 and 11,362 live patents in 2017, representing an increase of around 28 per cent over the 16-year period. A more refined analysis of the patent data by company size revealed that while small companies (less than $20 million in turnover) increased the number of patent filings by 15.4 per cent between 2002 and 2017, large company patent filings decreased by 10.9 per cent in the same period. However, both small and large companies show increases of 59.4 per cent and 44.6 per cent respectively in the number of patents being granted to them over the 16-year period.

Table 9 — Innovation (Patent) Output by Year

Year	Filed	Granted	Retired	Alive
2002	1,606	798	748	8,883
2003	1,632	900	824	9,255
2004	1,669	967	858	9,641
2005	1,841	1,004	836	10,227
2006	1,831	922	1,010	10,567
2007	1,743	841	1,182	10,762
2008	1,861	891	1,470	11,006
2009	1,777	917	1,673	11,174
2010	1,679	892	1,862	11,306
2011	1,643	1,019	2,032	11,516
2012	1,735	1,089	2,163	11,715
2013	2,493	974	2,172	11,618
2014	1,342	994	2,228	11,436
2015	1,492	1,136	2,446	11,467
2016	1,774	1,317	2,669	11,590
2017	1,836	1,120	2,811	11,362

Source: ABS BLADE Integrated Data: 2012-2018

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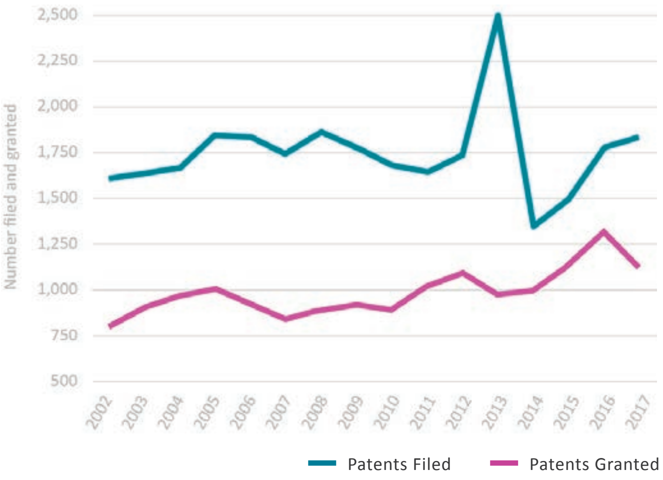
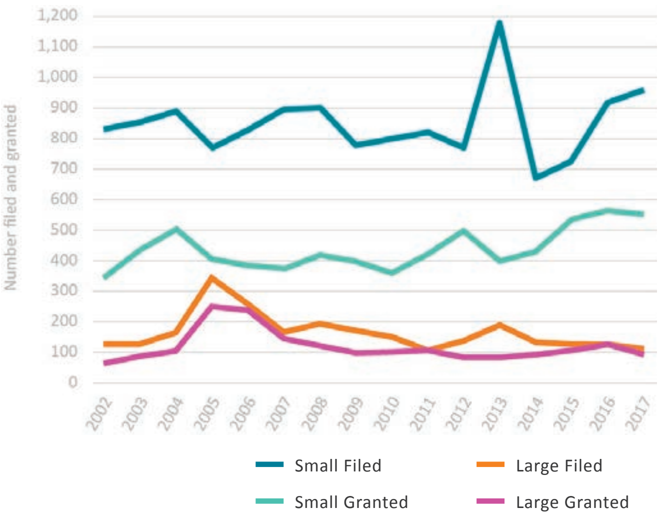
Figure 7 — Number of patents filed and patents granted, private companies in Australia 2002-2017



Source: ABS BLADE IPLORD Integrated Data: 2002-2017

Figure 8 — Number of patents granted and patents filed by small and large private companies: 2002-2017



Source: ABS BLADE IPLORD Integrated Data: 2002-2017

Against this background, we examined the average impact of R&D tax subsidies on private business innovation output as measured by number of patents filed and number of patents granted over the 16-year period (2002 to 2017).[14] This time period not only allows comparisons between the Tax Concession (2002-2011) and the R&DTI (2012-2018) regimes, but also estimates of innovation outputs for large and small private companies. We undertook this analysis by assessing the extent to which a given increase in a company's R&D expenditure generated by tax subsidies led to an increase in the company's patent output measured by number of patents filed and patents granted.

Thomson and Skali (2016) specifically examined the relationship between the amount of R&D investment of R&D-active companies claiming an R&D tax subsidy and 'similar' R&D active companies which do not claim a tax subsidy. We extended their study by examining whether innovation output is influenced by R&D-active companies claiming an R&D tax subsidy (the treatment group) compared to 'similar' R&D-active companies that do not claim a tax subsidy (the counterfactual group). Results show private R&D-active companies that claimed an R&D tax subsidy over the entire sample period (2005 to 2018) were associated with a four per cent higher level of patents filed within three years of receiving a tax subsidy compared to the counterfactual. During the R&DTI period 2012 to 2018, private R&D-active companies claiming an R&D tax offset were associated with a three per cent higher level of patents filed within three years of receiving a tax offset, while R&D-active companies claiming an R&D tax offset after the introduction of the $100 million R&D expenditure threshold in 2014 were associated with a five per cent higher level of patents filed within three years of receiving a tax offset, compared to the counterfactual. When we extended the analysis to private companies being *granted* a patent, it emerged that R&D-active companies claiming an R&D tax offset were associated with a one per cent higher level of patents granted within three years of receiving a tax offset, while R&D-active companies claiming an R&D tax offset after the introduction of the $100 million R&D expenditure threshold in 2014 were associated with a three per cent higher level of patents granted within three years of receiving a tax offset. But these increases on companies being *granted* a patent are not significantly different to those of R&D-active companies that do not claim a tax subsidy.

We also assessed whether a company's decision to introduce new goods or services, operational processes, managerial processes, or marketing methods – a measure of innovation used by the ABS in their annual Business Characteristics Survey (BCS) – was influenced by R&D-active companies claiming an R&D tax subsidy compared to the counterfactual. Our analyses of the BCS in the BLADE environment shows that R&D-active companies claiming an R&D tax offset were associated with a 68 per cent higher level of innovation as indicated by the introduction of new goods or services, operational processes, managerial processes, or marketing methods, compared to R&D-active companies that do not claim a tax subsidy.

The effect of R&D tax incentives and R&D business investment on firm-level employment

Academic literature on small business came to prominence when Birch (1979; 1981), in a report for the US Department of Commerce on the job generation process, argued that small businesses generated a disproportionately large share of new net jobs in the US. Prior to publication of Birch's report, research had shown that employment growth was dependent on the size of the enterprise, whereas Birch's (1981) research demonstrated that job growth was inversely related to firm size. This new research spurred a common belief among economic policy makers and researchers that small companies grow faster than larger companies, and that smaller enterprises are a more important source of job creation, leading some to reject Gibrat's law (e.g., Calvo, 2006; Neumark et al., 2011), which essentially states that company growth is proportional to size.

More recent systematic reviews of the empirical literature on the economic contribution of small and young companies generally provide support to the propositions that small companies grow faster, and are important drivers of employment, productivity and innovation. A meta-analytic examination of empirical research into the economic value of entrepreneurship, comprising 57 unique studies between 1995 and 2007, and conducted by Van Praag and Versloot (2007), concluded that "entrepreneurs create more employment than their counterparts, relative to their size" and that this result is unambiguous (p. 377). The review also revealed that while entrepreneurs and small companies spend less on R&D, resulting in fewer patents and innovations being generated by these companies, the quality of innovations and the efficiency with which these innovations were produced was significantly higher for entrepreneurs and small companies compared to larger companies (Van Praag and Versloot, 2007).

As R&D plays a vital role in raising both employment and productivity (Griliches, 1992; Romer, 1990), a relatively large body of literature evaluates the effects of public R&D subsidy programs on companies' R&D investment, with most research focusing on possible crowding-out effects (see Hall & van Reenen, 2000 for a review of the literature). Further examples of evaluation studies conducted internationally on specific schemes include the US Small Business Innovation Research program (Wallsten, 2000), R&D subsidies for manufacturing companies in Israel (Lach, 2002), German R&D subsidies (Czarnitzki & Licht, 2006), and the tax credit scheme in the Netherlands (Lokshin & Mohnen, 2007).

To add to this body of knowledge, this White Paper provides evidence of the effects of the R&DTI on Australian employment. SMEs make an important contribution to Australia's growth in employment¸ with small businesses (including micro-businesses) employing approximately 4.72 million people and accounting for 41 per cent of total employment (ABS, 2021). Small businesses also account for approximately 34 per cent of Industry Value Added (IVA) and around 60 per cent of total employment growth, with 29 per cent of all wages and salaries in the private sector being attributed to this sector in the financial years 2012-13 and 2017-18 (Gilfillan, 2020). Using a matched sample of R&D-active companies claiming an R&D tax subsidy (the treatment group) compared to 'similar' R&D active companies that do not claim a tax subsidy (the counterfactual group), our analysis showed private companies that increase their R&D expenditure, patent filings, claim an R&D tax offset, and innovate via introducing new goods or services, operational processes, managerial processes, or marketing methods, were associated with positive and significant increases in full-time employment (3.8%, 3.7%, 8%, and 2.6%, respectively) compared to the counterfactual. Furthermore, similar positive and significant associations were observed for small companies with less than $20 million in turnover. Full-time employment among small businesses increases on average by 5.2 per cent when these entities boost their R&D expenditures, patent filings, claim R&D tax offsets and innovate via introducing new goods or services, operational processes, managerial processes, or marketing methods (4.2%, 5.6%, and 7.8%, respectively) compared to small companies that do not claim a tax offset. In summary, our analysis demonstrates that innovation inputs such as R&D expenditure and tax offsets and innovation outputs such as patents are important sources of firm-level employment among private companies in Australia, especially among small businesses where on average the rate of employment is higher for these entities compared to larger businesses.

The effect of R&D tax incentives and R&D business investment on firm efficiency

We also examine the effect of incentives on corporate efficiency. We estimate the efficiency of private companies by utilising a Cobb-Douglas production stochastic frontier model to create a measure of relative efficiency of each private company within its respective industry for each year between 2006 and 2018. We estimate an efficient frontier for all private companies across 18 industries (except for companies operating in the finance and insurance services and rental, hiring and real estate industries) over the 13-year period by assessing the amount and mix of resources used by the company to generate output, measured by total income, within the company's industry. The inputs for each company are measured by the cost of goods sold, total leases, total expenses, non-current assets and R&D expenditure. We expect companies that operate on the frontier are the most efficient and, hence, assign these companies a score of one. In contrast, companies assigned lower scores (less than one) are deemed inefficient relative to companies operating on the frontier. Hence, the further the score is away from unity, the lower its efficiency.

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Figure 9 — Technical efficiency of private companies in Australia: 2006-2018

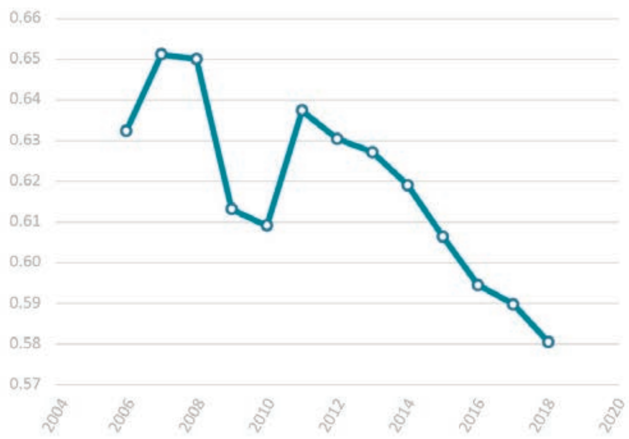
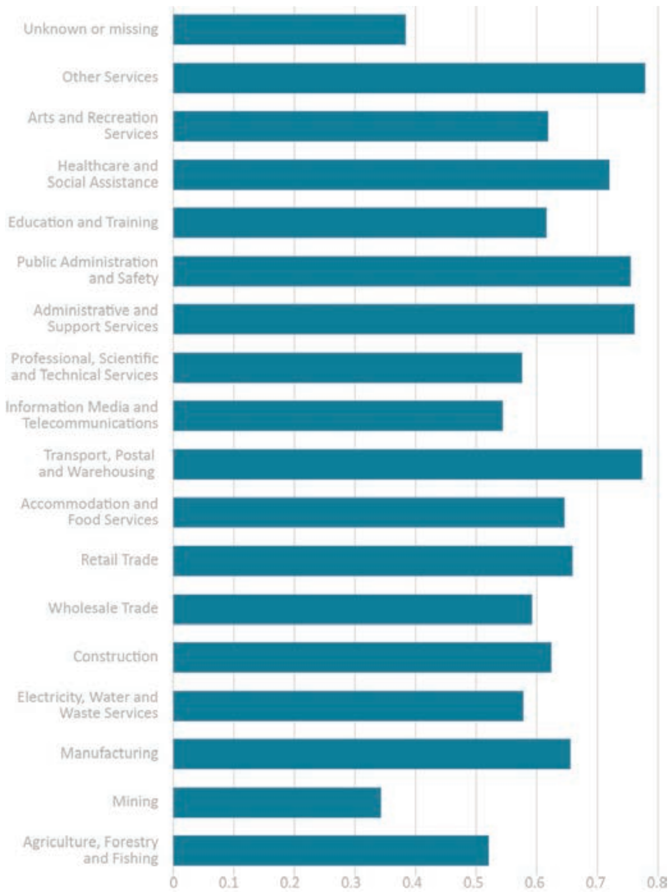


Figure 10 — Mean technical efficiency of private companies in Australia by industry: 2006-2018



Analyses of the data in the ABS BLADE environment shows that the technical efficiency of private companies declined on average by 8.21 per cent across all industries in Australia between 2006 and 2018, with the highest average efficiency score of 65 per cent observed in 2007, decreasing to 58 per cent in 2018 (see Figure 9). The most efficient industries were "other services" with an average score of 74.6 per cent, followed by transport, postal and warehousing (73.9 per cent), administrative and support services (72.9 per cent), public administration and safety (72.3 per cent), with resources sectors including agriculture, forestry and fishing (49.8 per cent) and mining (32.7 per cent) showing the lowest efficiency scores (see Figure 7). It appears that medium-size companies are more efficient (64.1 per cent) than small (62.5 per cent) and micro (60.7 per cent) businesses, while mature companies are more efficient (62.3 per cent) compared to young (61.8 per cent) and start-up (60.4 per cent) companies.

Econometric results show that innovation inputs such as R&D expenditure and innovation outputs such as patent filings are positively associated with private company efficiency. However, the results demonstrate that the significant and positive effects of R&D expenditure on firm efficiency are noticeable only after the third year of undertaking R&D activities. The results also show a significant positive association between firm size and efficiency scores, with large companies on average four per cent more efficient than smaller companies (less than $20 million in turnover). Similarly, mature companies (operational between five and ten years) are more efficient than young (two to less than five years) and start-up (less than two years) companies.

Characteristics of private companies undertaking university-industry cooperation

Although the OECD (2017) highlights that Australian R&D is conducted largely without collaboration between industry and research providers, and Australia has one of the lowest rates of collaboration on innovation between private businesses and universities among OECD countries, the research literature is limited in its examination of this issue. Analyses of private companies in Australia involved in collaboration with universities reveals that larger companies are not only more likely to collaborate with universities compared to smaller companies, but are also positively and significantly associated with more patent filings over time. Using a matched sample of R&D-active companies claiming an R&D tax subsidy (the treatment group) compared to 'similar' R&D-active companies that do not claim a tax subsidy (the counterfactual group), our analysis shows large private companies that collaborate with universities increase patent filings by nearly 11 per cent after five years compared to the counterfactual companies. Similarly, R&D expenditures increase by 47.5 per cent and introduction of new goods or services, operational processes, managerial processes, or marketing methods increase by 54.8 per cent in companies that collaborate with universities compared to the counterfactual company group.

Lack of adequate skills in R&D-active companies shows a significantly negative impact on patent filing activity, with filing activity decreasing by over 1 per cent in companies that report lack of adequate skills. By contrast, private companies involved in collaboration with universities are 35 per cent more likely to be associated with higher managerial skills, whereas R&D-active companies that have higher managerial skills are 17 per cent more likely to claim a tax offset. Smaller companies with lower managerial skills, however, are 54 per less likely to claim a tax offset compared to larger companies.

Recommendations

On the basis of our analyses and a comprehensive examination of recent studies of the R&DTI, we have formulated a series of policy recommendations aimed at increasing the efficiency and effectiveness of the R&DTI (and broader research and innovation system). Given the prevailing view that R&D by business is most effectively conducted in collaboration with researchers, and evidence of significant barriers to R&D activity faced by SMEs, the recommendations have a deliberate focus on SMEs and collaborative R&D. We expect this focus to increase both additionality and positive externalities resulting from the research. In total, we provide eight recommendations that collectively address a range of frictions that appear to prevent optimal research output. These recommendations are summarised in Table 10.

Table 10 — Summary of recommendations and frictions addressed

		R&D Activity Frictions				Collaboration Frictions			
		Costs of R&D	Funding	Skills	Regulation	Costs of R&D	Funding	Culture gap	Finding partners
1	Increased SME subsidies	✓	✓ (partial)						
2	Quarterly offsets		✓				✓ (partial)		
3	Collaboration vouchers			✓ (partial)		✓	✓	✓	
4	Collaboration premium			✓ (partial)		✓	✓ (partial)		
5	CRC investment			✓ (partial)		✓	✓	✓ (partial)	✓
6	Clarification of software eligibility	✓			✓				
7	Regulation simplification	✓			✓				
8	Experimental implementation				✓				

✓ Addresses ✓ (partial) Partially addresses

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Recommendation 1 — Increase SME subsidies

Encouraging research and development by SMEs should be a priority of the R&DTI. The OECD (2015) recommended that a primary focus of any R&D taxation relief should be to meet the needs of "young, innovative firms and stand-alone firms" (referenced by CIE, 2016), with R&D activity broadened across various sectors. Young, innovative companies are more responsive to taxation incentives, exhibiting greater levels of both additionality and spillovers (CIE, 2016).

Despite assertions that the R&DTI provides generous incentives for SMEs (CIE, 2016; Ferris et al., 2016), the magnitude of R&D tax relief is not substantial when compared to schemes in other OECD countries (see Table 5 and Table 6 for a summary of average refundable and non-refundable tax offsets for Australian companies between 2012 and 2018). Table A1 (see Appendix A) provides rankings of the strength of R&D incentives compiled by the OECD, with Australia's R&DTI for SMEs ranking outside the top third of countries. Based on the B-index, Australia ranks 16th and 23rd out of 48 countries for the strength of incentives provided to loss-making and profitable SMEs respectively, with the benefits for loss-making SMEs deriving predominantly from the refundability of the credits. France, the United Kingdom, Finland, the Netherlands, Korea, Canada and many other countries more heavily subsidise R&D by SMEs – and many of these countries are also expanding R&D at a faster rate than Australia (see Table A1, Appendix A).

Recent changes to the R&DTI further reduce the benefits for SMEs. *The Treasury Laws Amendment (A Tax Plan for the COVID-19 Economic Recovery) Bill (2020)* has altered tax credits offered to SMEs from 43.5 per cent to the corporate tax rate +18.5 per cent. Slated corporate tax rate reductions in coming years will reduce the benefits provided to SMEs. The decreases in the corporate tax rate for SMEs, while supportive for profitable SMEs, will increase the effective cost of engaging in R&D, especially for loss-making and pre-revenue SMEs reliant on refundable R&DTI credits to finance R&D.

Based on ABS BLADE data, (current) 15,979 large private companies received $27.0 billion (68 per cent) of total R&D offsets, while (current) 59,008 SMEs received $12.7 billion (32 per cent between 2012 and 2018. To continue supporting Australia's innovative SMEs, we recommend reverting to the fixed rate incentive (43.5 per cent) for SMEs. To fund this reversion, the Government may opt to reduce the reimbursement rate for large companies with low research intensity.[15] We have focused our recommendation on supporting SMEs (especially loss-making SMEs) as our earlier analysis provides strong evidence that SMEs are sensitive to changes in the rate of relief provided by the R&DTI. We believe that eroding the value of the R&DTI for SMEs disadvantages new, innovative businesses, and increases the likelihood that future businesses will establish R&D operations offshore.[16]

Recommendation 2 — Quarterly offsets

We believe the Government should act to help ease capital frictions and constraints for SMEs that currently limit R&D and collaboration activity. To this end, we propose that the Government revisit the *Tax Laws Amendment (2013 Measures No. 4) Bill 2013* with a view to expediting the return of cash to SMEs, and accordingly recommend a system of quarterly reimbursement for R&D credits. Consistent with the 2013 bill, we recommend quarterly refunds be restricted to SMEs (as only SMEs have access to refundable credits). To limit administrative burdens and reduce risks faced by SMEs that quarterly refunds are clawed back on ineligible research, we further recommend the quarterly offset be coupled with advanced registration of research programs that provides strong guidance to SMEs as to their compliance, providing certainty for both SMEs and the Australian taxpayer.

We put a priority on quarterly credits given the reasons provided by innovative companies for withholding R&D activity identified by Innovation and Science Australia (2016) and evidence from recent ABS surveys.[17] The ISA report found that over 25 per cent of innovation-active businesses cited *lack of access to additional funds* as restricting R&D activities, complementing ABS data showing that more than 20 per cent of smaller businesses suggest lack of funding prevents collaboration. Similarly, the ISA report shows that over 15 per cent of businesses cited *cost of development or introduction/implementation*. The ABS data confirms that these reasons are concentrated among SMEs. Similar results were also found by Ferris et al. (2016). The ISA report also shows that concerns regarding access to capital far outweigh concerns about government regulation and compliance (10-15 per cent) or adherence to standards (c. 5 per cent) – both of which appear of even lower concern than collaboration in the ABS data – supporting our recommendation that quarterly credits be made a priority despite the likelihood of increased reporting obligations or upfront administration to facilitate advanced registration.

As our empirical testing revealed substantially increased R&D activity following the introduction of reimbursable tax credits for loss-making SMEs, we expect quarterly refundable credits to directly address concerns over access to capital by SMEs by recycling tax offsets back to SMEs more rapidly, alleviating R&D funding constraints, particularly for pre-revenue SMEs with few alternative sources of financing. Australia's current approach builds in substantial delays to the reimbursement process. Most companies wait until year-end to provide annual submissions, which then require the approval of DISER before being reimbursed by the Australian Taxation Office alongside annual tax filing. The delay of up to 18 months in receiving reimbursements following expenditure meaningfully slows the recycling of R&D credits. In contrast, an effective quarterly credit scheme will bring forward cash availability, allowing SMEs to significantly increase the "velocity" of their investments in R&D, with data from ABS BLADE indicating that refundable credits for SMEs are in excess of 28.7 per cent of average SME turnover.

We anticipate that the use of quarterly credits would have only a marginal effect on government budgets, resulting from: (1) the one-off cost of shifting forward credit distribution; and (2) the risk of subsequent default.[18] Given the limited direct costs of employing quarterly credits, we view the potential benefits to SMEs and the innovation system to outweigh the effect on government budgets. Second, we expect only a limited impact on the efficiency of the registration system. While it is possible that administering the more frequent quarterly credit system may add further administrative hurdles to an already complex R&DTI system (KPMG, 2012; Deloitte, 2012), we see the use of quarterly credits as an opportunity to *improve* the approval process for eligible SMEs. We recommend expanding (and requiring) the use Advanced Findings for quarterly credits to pre-evaluate research programs at the project level ahead of undertaking the research activity, reducing the latency between research expenditure and refund. Applicants would engage in their research activity consistent with the approved plan. To better support compliance (and increase incentives for collaboration), the Government may also consider the feasibility of restricting quarterly credits to collaborative projects, leveraging the basic research, record keeping, compliance and verification infrastructure of universities (Mercuri & Birbeck, 2020), limiting deviation from pre-approved research plans.[19] Whether or not so restricted, given the importance of access to capital relative to regulation and compliance frictions (as shown by both the ISA (2016) and the previously discussed ABS data in Table 2), we view any further administrative issues as both manageable and of second-order importance relative to the benefits of improving the R&DTI as a source of funding.

Recommendation 3 — Collaboration incentive

To complement incentives for increased R&D activity, we make several recommendations explicitly focused on collaboration between companies and Australia's high quality research institutions.

As previously discussed, multiple data points suggest that Australia is a consistent underperformer in collaboration compared to its global peers. Data collected from ABS BLADE shows that less than 10 per cent of companies claiming R&D credits have engaged in collaborative research. Similarly, recent innovation system reviews provide evidence that companies tend to conduct research with minimal engagement with publicly funded organisations (ISA, 2016; OECD, 2017) – a consequence of cultural differences and the paucity of channels of communication and shared experience.

We view shortcomings in collaboration as an important concern. Limited engagement between industry and research organisations restricts access to the empirically observed benefits from industry-researcher collaboration. Collaborative research provides access to skills, resources and spillover effects that are otherwise unattainable from independent private research. SME-based research is argued to be more organic as a process (Griffith et al., 2003) and, consistent with Table 3, which shows a greater prevalence of skills deficiencies in innovative SMEs than in larger companies, is performed by staff with conflicting or broad roles and with varying levels of expertise (Freel, 2005; Veugelers, 2008) and in settings with fewer dedicated resources. Collaboration therefore allows SMEs to access to research talent and resources that are not otherwise attainable (Piergiovanni et al., 1997; Ganotakis and Love, 2011), and may enable more efficient research outcomes and yields on investment of government funds in R&D. Recent reviews have attempted to quantify these benefits. Universities Australia (2020) suggests the benefits of collaboration to be a return of $4.47 per dollar invested. The Department of Education's *Review of Research Policy and Funding Arrangements (2015)* suggests that the potential increases in business efficiency from collaborative research, relative to uncollaborative research, increases by a factor of three. Similarly, our analysis provides evidence consistent with the notion that collaborative research produces more successful patent and innovation outcomes.

Consistent with the stated objectives of the innovation system, we recommend that the R&DTI shift focus to explicitly incentivise research collaboration. The current R&DTI scheme provides preferential treatment to collaborative research, permitting claims of less than $20,000. We support previous reviews calling for additional support for collaboration (Ferris et al. 2016) and recommend extending the preferential status of collaboration with research institutions to include a premium of 20 per cent to the relief provided by the R&DTI,[20] reflecting the additional non-private benefits derived from collaboration.

We further recommend that this collaboration premium be interpreted broadly to permit many forms of beneficial collaboration, maximising public benefits and spillover effects. For example, recent reviews have drawn attention to the limited movement of human capital between research and industry sectors as a primary obstacle to overcoming cultural barriers (eg. ISA, 2016). According to the ISA, and based on OECD data, only one-third of all researchers are employed in industry, with an even smaller percentage of PhD graduates seeking employment outside government research institutions – rates well below OECD averages.[21] Following the examples of countries with progressive R&D collaboration incentives (for example, France), the collaboration premium should be extended to support a variety of PhD employment opportunities in industry including PhD graduate recruiting, industry PhD partnerships, PhD internships, and co-funded PhD placements.[22] By placing PhD students or graduates in industry, the collaboration premium can incentivise a primary mechanism of knowledge transfer between universities and industry (Harryson et al., 2007; Thune, 2009; Gertner et al., 2011), and assimilate academic and industry cultures through the sharing of human capital and perspectives. Ultimately, industry-supported PhD placements will also help support continued Higher Degree Research placements and promote research training.

We recommend the collaboration premium despite the limitations cited by the CIE (2016), the scarcity of causal evidence from experimental policy implementations,[23] and several other limitations. The CIE recommended against a collaboration premium on the basis that cultural differences are likely to limit the effect of the premium on research activity. However, as shown in Table 2, cultural differences are of lesser concern to innovative companies and we also make this recommendation alongside other recommendations that support the breakdown of any such cultural barriers – specifically, the hiring or placing of PhD students within industry and the use of innovation vouchers redeemable for collaboration. Moreover, despite any cultural frictions, the cost of the collaboration incentive is directly proportional to collaboration activity. Given the limited collaboration activity that currently takes place, costs on introduction should be minimal. To the extent that the incentive drives both additionality and collaboration, the increase in costs should be proportional to the achievement of the premium's objective.

We also acknowledge the potential for the collaboration premium to place additional burdens on the university sector and disrupt existing university structures. For example, a focus on collaborative research with industry may compromise the existing focus on academic research and teaching (Ferris et al., 2016). We make several observations related to this concern. First, recent reviews suggest that slack in the system should continue to support academic freedom and a focus on primary teaching and academic research objectives alongside incentive for industry collaboration (Ferris et al., 2016; ISA, 2016). Second, like some other recent reviews, we recommend that some restructuring of university administration be undertaken to promote collaboration and innovation outcomes. For example, remuneration and hiring structures may have to broaden their focus beyond academic teaching, research and administration when measuring performance for promotion, and additionally include the development of industry networks and projects as additional measures.[24] Universities may also be encouraged to develop administrative support for academics looking to patent and develop academic research into collaborative products and services (EC, 2007). While such changes would undoubtedly realign the focus of university academics away from traditional priorities, these changes are consistent with the ARC's definition of and focus on research impact – "research impact is the contribution that research makes to the economy, society, environment or culture, beyond the contribution to academic research" – and the positive spillover effects from more directly incentivising collaboration should justify the costs of the premium (Ferris et al., 2016).

Recommendation 4 — Collaboration vouchers

While this White Paper focuses on tax incentives as the primary lever of the Australian Government to influence R&D activity, we also argue that additional incentives and systems can complement the R&DTI and aid in addressing the limited access to capital of SMEs and overcome any perceived cultural barriers that restrict collaboration. One such effective tool is the provision of innovation vouchers – an approach for which there is strong causal evidence supporting additionality and collaboration outcomes.[25] Innovation vouchers provide conditional access to capital for use in R&D – redeemable only on presentation for research collaboration with a university or other publicly-funded research institution. Hence, the vouchers explicitly require industry to partner with research institutions to extract value from the grant.

Evidence from several overseas applications of innovation vouchers shows improvements in additionality and spillovers. This evidence comes from two policy experiments, which we argue later in this White Paper provide a high quality of causal testing. In the United Kingdom, the business ministry (BEIS) used one version of the model to encourage small business to engage consultants and seek advice to improve efficiency and effectiveness (Bravo-Biosca, 2020).[26] In the Netherlands, the Government introduced €7,500 vouchers in 2004-2005 focused explicitly on fostering research collaboration and addressing the obstacles to knowledge distribution discussed earlier in the White Paper.[27] Subsequent research into the experimental program showed that the vouchers stimulated first connections with publicly funded research institutions and provided clear evidence of additionality – 90 per cent of voucher recipients engaged in collaborative research (vs 10 per cent in the control group); 76 per cent of SMEs indicated they had commissioned research because of the vouchers; 86 per cent of control companies suggested they would have conducted research if they had a voucher; and many participating companies committed extra capital to conduct research programs larger than €7,500 (Roelandt and van der Wiel, 2020). Vouchers also resulted in higher rates of R&D, employment and business survival in both the short-term and the long-term (Cornet et al. 2006, SQW, 2019; Sala et al., 2016; Bravo-Biosca, 2020; Roelandt and van der Wiel, 2020).

The causal nature of the evidence gathered from experimental policy programs provides strong support for the use of vouchers to stimulate R&D activity by SMEs. Consistent with recent support for such programs across the world (EC, 2007; Mercuri and Birbeck, 2020),[28] we recommend that the Australian Government commence a lottery-based policy experiment using innovation vouchers. The vouchers should be delivered at random to program-registering companies and be redeemable only with Australian research institutions. As the average size of R&D taxation offsets for small and micro companies in Australia exceeds $100,000, and the existing legislation provides incentives for collaboration for projects valued below $20,000, we recommend the Government commence the experiment with vouchers of at least $20,000. While small compared to the average cost of complete research projects, the successful results produced by foreign experimental applications – including use of €7500 vouchers in the Netherlands – suggest that $20,000 should be a significant inducement for Australian SMEs to participate, while still providing further incentives for SMEs to commit additional capital for projects of more significant scale. Consistent with our recommended approach to a collaboration premium in Recommendation 3, we suggest that innovation vouchers may be spent on the recruitment or funding of PhD students or graduates, enabling the positive spill overs from such recruitment and permitting SMEs with smaller projects to utilise vouchers by directly acquiring intellectual talent.

RESEARCH AND DEVELOPMENT TAX INCENTIVES: IMPROVING INDUSTRY-UNIVERSITY COLLABORATION

Recommendation 5 — Expand investment in co-operative research centres

A strong case can also be put forward for increased support for Australian knowledge sharing infrastructure. The ISA review (2016) argued that Australia's strong publicly funded research institutions were under-utilised by Australian businesses. In part, the review suggested that the under-utilisation stemmed from a lack of knowledge-sharing infrastructure and investment, with networks between industry and research organisations relatively poor. Data provided by the ISA (2016), and reproduced in Table 11, shows that the majority of knowledge transfer funding is provided through research grants, with minimal overall funding provided in programs or centres for research. Co-operative research centres and other research centres (excluding the Renewable Energy Agency and defence industry programs) receive 6 per cent of funding from the total amount of money made available to the knowledge transfer program. This equates to approximately 2 per cent of total research funding. This deficiency affects collaboration between industry and research organisations and prevents the maximisation of research investment.

As discussed previously, Australia's R&D policy is focused on incentivising business expenditure on R&D through taxation relief. OECD data shown in Table A3 (see appendix) demostrates that Australia ranks second only to the Netherlands in the proportion of R&D support through the tax system – as against direct grants. Australia provides more than six times the tax relief relative to grants. Other OECD countries have more of a balance between direct funding and taxation relief. France, the United Kingdom, China, Korea and New Zealand all provide approximately equal support through tax and direct programs, and many innovative countries, such as Germany and Switzerland, do not provide substantial support through tax programs at all.

We recommend that the Government place a greater emphasis on supporting knowledge sharing infrastructure through CRC grants. Following recent reviews identifying the benefits of CRCs (Miles, 2015; ISA, 2016), we recommend the Government expand their role and funding. The CRC program was established in 1990 to address the disconnect between business and industry. Despite attracting minimal funding, CRCs have been shown to be particularly effective at supporting R&D (ISA, 2016). Since inception, the 225 CRCS and 111 CRC-Ps have been considered to be "the glue in Australian industry-research collaboration" (Miles, 2015). They bring together industry and researchers, with investment resulting in substantial returns in the form of research collaboration and activity in the order of 3:1, and delivering both positive spillovers and research publications (Allen Consulting, 2012). CRCs also foster the expansion of networks, and support the training of PhD researchers. Importantly, CRCs produce research that is industry-led, and draw on the commercialisation interests of industry to motivate research activity (unlike ARC-linkage grants) (Miles, 2015).[29] These centres create a co-operative team of researchers and "research users". Investment in CRCs, therefore, is directly targeted at overcoming the shortcomings identified in the ISA (2016) system review.[30]

Consistent with the findings of the Miles review (2015), and with recent calls from former chair of Innovation and Science Australia Bill Ferris,[31] we recommend that the Government continue to expand the role of project-based CRCs (CRC-Ps), with a view to providing CRC support to SMEs. Project-based CRC-P grants provide support for smaller project and research pipelines that might otherwise not attract CRC funding. They are relatively short-term, with funding granted up to three years, and are generally smaller in scale than full CRCs. CRCs also frequently hire research-trained PhD staff and students (Miles, 2015). Similar programs in Germany (Fraunhofer Institutes) and the UK (Catapult Centres) have been widely credited with stimulating collaborative research from SMEs (Miles, 2015; ISA, 2016). Throughout this White Paper, we have presented evidence suggesting that SME research budgets are likely to be smaller than those of larger companies. Accordingly, providing access to CRC grants for smaller projects is more likely to address the collaboration issues of SMEs than increasing the funding for long-term CRCs.

Table 11 — Knowledge Transfer Funding by Program 2016-2017

Knowledge Transfer Program	Government Funding ($m) (2016/17)	Proportion of Knowledge Transfer Funding	Proportion of Total Funding
Research Block Grants	1,777.90	42%	17%
NHMRC Grants	840.5	20%	8%
ARC Grants	744.4	17%	7%
Rural R&D	292.5	7%	3%
Australian Renewable Energy Agency	190.3	4%	2%
Defence Industry and Innovation Programmes	160	4%	2%
Cooperative Research Centres	149.8	4%	1%
Industry Growth Centres	60.7	1%	1%
Entrepreneurs Program	35.2	1%	0%
Global Innovation Strategy	8.6	>0%	0%

Source: ISA (2016)

Recommendation 6 — Software and R&D

Australia adopts a relatively strict definition of eligible R&D activity. As discussed previously in the White Paper, the R&DTI focuses on *basic* research resolved through experimental processes, as opposed to applied research or experimental development, consistent with the OECD Frascati Manual (2015). Thus, research must be novel and provide incremental knowledge, with the objective of maximising spillovers by sharing basic knowledge (Ferris et al., 2016).

The restriction has not, however, resulted in large volumes of new-to-world research, with Australian companies lagging foreign peers (Australian Government, 2016). Accordingly, the restriction to basic research has been the subject of substantial debate, with some companies in "innovative" industries effectively locked out of the R&DTI because their innovation does not align with the current interpretation of the R&DTI. In contrast to the preference for basic research, some argue that competitive R&D incentives should be broadened to include commercially viable research so as to incentivise more R&D and maximise private benefits and business investment in R&D (see eg. Stepp and Atkinson, 2011; Atkinson, 2019), which may then flow on to economy-wide outcomes. Such research may foster collaboration and lead to valuable patent filings, employment and economic growth.

Arguably, the most contentious debate involves the software industry, where an increase in taxation office audits has raised risks in accessing the R&DTI for otherwise seemingly innovative companies (see e.g., Kennedy, 2020; Sadler, 2020a; Sadler, 2020b; Eyers, 2020), subjecting software companies to denial of otherwise expected R&DTI offsets, clawbacks of previously awarded credits and/or significant fines. The audits are increasingly frequent. In 2018-2019, $200 million was clawed back from 13,000 companies, compared with $115 million in 2016-17 from nearly half as many audits (Sadler, 2020b). These clawbacks have had significant effects on software companies. For example, Airtasker, had its 2014 and 2015 R&DTI claims ex-post rejected by AusIndustry, exposing the company to ex-post repayment of the R&DTI and penalties of up to 75 per cent.[32] Such punitive application of compliance rules discourages SMEs seeking R&DTI offsets, thereby reducing the benefits of the system and effectively increasing the costs of innovation activity. For example, young Australian start-up Paypa Plane publicly eschewed making R&DTI claims in 2019, reportedly concerned about the prospects of clawed back credits and penalties. Given that nine out of ten start-ups suggest that the R&DTI is important to success (Eyers, 2020), the present interpretation of the R&DTI appears not-fit-for-purpose in an economy with substantial investment software innovation.

While the purpose of the R&DTI is to support public benefits, rather than private benefits, from research and innovation, we contend that the substantial risk faced by software companies accessing the R&DTI is economically counter-productive, creating uncertainty in an otherwise important and growing industry. Software production is a substantial and highly innovative segment of the economy, and many other countries provide strong incentives to attract software businesses. Data in Table 12 suggests that software, as an industry, is economically significant. Combined, there are more than 55,000 businesses in Australia designing software and computer systems, employing close to 250,000 people. Companies specialising in software production, our primary focus, produce just under $5 billion in revenue and over $1 billion in industry value add. More importantly, the software industry is expected to be an important contributor to the future growth of Australian business. Industry value add has grown by 105 per cent in five years, with employment up 57 per cent and wages up 68 per cent in the same period. Computer systems design, a similar field, is already economically substantial, providing more than $34 billion in value add and generating more than $26 billion in wages. Collectively, these industries provide meaningful employment opportunities to Australian innovation workers, and software specifically represents one of the fastest growth sectors of the Australian economy.

Given the economic significance of the software industry and its reliance on innovation, we recommend that the R&DTI be amended to (a) broaden the scope of eligible R&D activity to include software-related research activities; and (b) provide clear advice on the requirements for software to comply with the requirements of the R&DTI. These recommendations are in line with the demands of software industry for support (see eg. Riley, 2020) and the approach of overseas jurisdictions. Providing meaningful support through the R&DTI to the software industry will increase the competitiveness of the Australian incentive framework and assist in retaining intellectual property and talent.[33]

Our recommendation to provide clarity on software eligibility should also improve the efficiency of the system. Non-compliance with eligibility criteria discourages both investment in software and use of the R&DTI, and also absorbs ATO resources in subsequent enforcement. By providing clear guidance on the eligibility of software companies to the benefits of the R&DTI – whether the Government accepts the recommendation to broaden the definition or not – the Government will reduce the compliance risks and perceived uncertainties that currently create barriers to innovation in the software industry.

Table 12 — Some Key Characteristics of the Australian Software Publishing and Computer System Design Industries: 2019-2021

Year	Revenue	IVA	Estab.	Enterprises	Employment	Wages
	($m)	($m)	(Units)	(Units)	(Units)	($m)
Software Publishing [a]						
2011–12	1,276	454	698	618	4,209	316
2012–13	1,386	478	900	796	5,647	429
2013–14	1,656	515	1,587	1,430	6,549	526
2014–15	2,090	584	1,514	1,377	7,425	586
2015–16	2,741	606	1,465	1,312	7,913	669
2016–17	3,110	546	1,428	1,237	8,969	698
2017–18	3,514	657	1,468	1,266	9,943	738
2018–19	4,261	724	1,350	1,185	10,747	929
2019–20	4,833	1,199	1,371	1,172	11,634	986
Computer System Design [b]						
2012–13	49,754	27,492	50,621	46,229	181,000	20,228
2013–14	48,779	27,104	51,977	47,598	188,000	20,129
2014–15	49,972	28,453	52,334	47,969	198,000	21,757
2015–16	52,957	29,391	53,103	48,763	200,000	22,984
2016–17	53,930	29,400	54,415	50,014	206,000	22,767
2017–18	57,058	30,876	55,939	51,462	218,000	24,314
2018–19	64,339	33,732	57,816	53,238	230,000	26,397
2019–20	65,438	34,263	58,298	53,731	233,000	26,934
2020–21	67,002	34,036	58,720	54,170	232,000	26,732

[a] 5420 — Software publishing mainly engages in creating and disseminating ready-made (non-customised) computer software (see ABS Catalogue No. 1290.0, p. 184). Some major players are Atlassian, MYOB, Wisetech Global, Xero.

[b] 7000 — Computer system design and related services mainly engages in providing expertise in the field of information technologies such as writing, modifying, testing or supporting software to meet the needs of a particular consumer; or planning and designing computer systems that integrate computer hardware, software and communication technologies (see ABS Catalogue No. 1290.0, p. 320).

Source: IBISWorld, June & November 2020

Recommendation 7 — Registration and regulation changes

The current R&DTI is encumbered by substantial "red-tape" that adds to compliance costs and discourages the use of the incentives (Mercuri and Birbeck, 2020), reducing the effectiveness of any subsidy programs. In brief, the R&DTI requires companies to register their activities within 10 months of the end of the income year.[34] Those annual registrations are reviewed by DISER, which provides approval of offset eligibility. Applicant companies then lodge their taxation filings with the Australian Taxation Office. Once these filings are confirmed and approved, applicants receive offsets or refunds.

We recommend that the Government undertake a process review for accessing the R&DTI and other research infrastructure, with a focus on streamlining access for companies undertaking R&D. The current system requires companies to lodge applications with DISER on an annual basis (either through the basic program or seeking Advanced Finding). This requires a substantial duplication of effort and delay in filing with the Taxation Office, as approval by DISER is a prerequisite for claiming R&DTI offsets or refunds (CIE, 2016). To reduce the duplication of effort and more closely match the application process to the nature of the research process (which may vary between short-term and long-term), we support the argument of the CIE (2016) and recommend that DISER increase the scope of its Advanced Finding channel by providing advanced findings on a project-by-project basis, allowing the duration of registration (on a project basis) to more closely match the long-term nature of research. Research projects frequently take more than one year to complete, and providing certainty to registrants across the life of the project will reduce the risk of them unexpectedly losing access to offsets and facing the prospect of R&DTI claw backs. This longer-term registration system would bring Australia into line with several other strong research economies, including the United Kingdom and New Zealand, both of which have incentive programs that provide longer-term registration to small/newer applicants. To further improve the efficiency of handing R&DTI claims, the Government should examine the feasibility of incorporating tax claim review functions of DISER within the ATO, creating a "one-stop shop" for R&DTI claims.

Recommendation 8 — Data availability and policy experimentation

Finally, we recommend changes to standards for policy implementation to future-proof Australia's research innovation. Constructing a fit-for-purpose (or "best practice") R&D incentive scheme is challenging given the paucity of causal evidence on the effect of individual R&DTI elements on the R&D activity of both large and small businesses and the difficulty in constructing a one-size-fits-all optimal R&D incentive program (OECD, 2019). For the most part, empirical research has focused on the effect of variations in the strength of incentives. Evidence on the effectiveness of R&D incentive features such as eligibility, quarterly reimbursement, minimum claim thresholds, collaboration premiums and alternative funding arrangements is scarce. Accordingly, policy makers are left in an unenviable position of having to make policy based on anecdotal evidence, overseas experience and theoretical argument.

While we identify several limitations in producing causal research on R&D policy, the most significant complication arises from the nature of policy implementation. Policy is generally implemented in the form of a policy package across all businesses. Individual features of these policy packages are rarely introduced in isolation. Accordingly, those charged with policy evaluation cannot identify an appropriate counter-factual group with which to compare the intervention of policy and argue its merits. For example, the recent *Treasury Laws Amendment (A Tax Plan for the COVID-19 Economic Recovery) Bill (2020)* contains R&DTI amendments to the rate of tax relief; the classification of companies for relief (research intensity); and adjustments to the maximum claim thresholds for refundable credits. Thus, causally attributing any changes in R&D activity to individual mechanisms is econometrically challenging.

We argue that access to causal evidence is vital for effective policy making. Failure to produce causal evidence on policy changes will, long term, reduce the efficiency of the program as the Government's policymakers cannot identify optimal policies. Consistent with recent calls for stronger evidence related to R&D policies (see, for example, CIE, 2016; Thompson and Skali, 2016), we recommend that the Government commit to future changes in research and innovation policy being implemented with ex-post evaluation of the policy as a priority. With the ability to identify effective policy, policymakers can knowingly select between effective and ineffective policy features. Best practice research calls for the use of staggered implementation of new policy across businesses or time (Veugelers, 2008; CIE, 2016; Thomson and Skali), creating quasi-experimental settings from which researchers can gather evidence and present feedback on the effectiveness of policy implementations. These settings, ideally, should be constructed prior to implementing new policy packages in a "sandbox" allowing for experimentation to determine optimal policy to introduce in legislation.

Data from these experimentations should then be publicly disseminated for detailed evaluation (CIE, 2016). In keeping with recent innovations by the Australian Government to provide more open data, we recommend that this data be made as widely and readily accessible as possible. To promote access, the data should be provided at minimal cost or open source, regularly updated, in machine readable format, and with non-sensitive identifiers present to allow for in-depth analysis. Such an approach would facilitate researchers to produce causal evidence on policy attributes, future proofing the R&DTI against changing circumstances, costs and economic conditions. As identified by ISA (2016), recent innovations in data availability should be applauded, and the increase in open datasets represents a boon for research and accountability. For example, the implementation of ABS BLADE has provided access to a wealth of information on private companies in Australia that allows for detailed policy research. Experimental policy implementations should follow this open data approach, and the Government should ensure that data from these studies can be linked through ABS BLADE and other data resources using relevant identifiers to allow for comprehensive study and evaluation.

Endnotes

1. See article "We can boost industry through science: Foley" in the Australian Financial Review (18 March 2021).
2. See Regulation Impact Statement available at https://ris.pmc.gov.au/2020/01/14/better-targeting-research-and-development-rd-tax-incentive.
3. See KPMG analysis available at https://home.kpmg/au/en/home/insights/2020/10/r-d-tax-incentive-changes-investment-future.html
4. See https://www.innovationaus.com/an-open-letter-to-the-pm-from-aussie-tech/ for discussion of the Open Letter. The suggestion of more extensive support by foreign OECD countries is consistent with data shown in Table A3 (see Appendix A).
5. See https://www.universitiesaustralia.edu.au/media-item/17000-uni-jobs-lost-to-covid-19/
6. OECD (2015), available at: https://doi.org/10.1787/9789264239012-en.
7. According to the OECD, "innovation collaboration" involves active participation with other organisations in joint innovation projects (i.e., those aimed at introducing a new or significantly improved product or process), but excludes pure contracting out of innovation-related work. It can involve the joint implementation of innovations with customers and suppliers, as well as partnerships with other companies or organisations (OECD, 2017).
8. On average, only 13 per cent of innovating SMEs in countries surveyed by the OECD develop their innovations in collaboration with universities or research institutions, compared to 31 per cent for large companies.
9. The seven pillars are: Institutions; Human capital & research; Infrastructure; Market sophistication; Business sophistication; Knowledge & technology outputs; Creative outputs (Cornell University, INSEAD, and WIPO, 2020).
10. A full discussion of R&D relief schemes can be found at OECD (2020) or EY (2020). These discussions provide extensive detail as to policies and procedures for R&D tax credits or other systems of relief.
11. Further details on a selection of countries can be found in Table 4.
12. RDAs operate separate from the RDEC or SME scheme. There is no limit to the deductions available under RDAs. These costs do not have to be traced to specific projects.
13. The RCC provides a credit of 20 per cent of the R&D expenditure additional to a so-called fixed-base percentage. The percentage is computed using the research intensity (eligible R&D expenditures scaled by total receipts) of the current taxation year multiplied by the average of the four prior years of gross revenue of the taxpayer. An alternative calculation exists for start-up companies without sufficient financial history. The ASC provides a credit of 14 per cent (or 6 per cent for start-up companies) of excess R&D expenditure. The base is computed as 50 percent of the average R&D expenditure for the 3 preceding years.
14. At the time of analysis, the Intellectual Property Longitudinal Research Data (IPLORD) ended in 2017
15. In a similar change, South Korea implemented substantial changes to their R&DTI since 2009 to reduce the incentives to large companies in favour of providing stronger incentives to SMEs. While there is no causal support for the correlation, since 2009, Korea has increased its R&D output considerably and has become one of the highest patent generating countries in the world.
16. This issue has been of considerable concern to industry groups. See, for example Atlassian (2020).
17. Concerns are similarly identified in reviews by the CIE (2016) and Ferris et al. (2016).
18. The acceptance of default risk results from "early" payment of credits related to R&D activity for companies that subsequently default prior to tax filing and settlement. Given that we argue for early payment of actual expenditures, these expenditures should rightly be deductible.
19. We are also cognisant of the issues discussed in the review by Ferris et al. (2016) regarding the use of quarterly credits. As discussed in their report, respondents suggest that quarterly credits may need to be restricted to businesses with strong taxation records – to ensure that companies do not default on claim. As loss-making businesses are unlikely to possess such records, Ferris et al. (2016) suggest that the program would be restricted to companies unlikely to meaningfully benefit from such an arrangement. We suggest that restricting access to collaborating companies likely addresses this concern in several ways: (1) Quarterly reimbursement could be restricted to collaboration payments, thereby shifting any default on payments or lost revenue from the research institution to the tax office at zero net cost to the government; (2) Quarterly reimbursement may, in itself, lessen the risk of default capital is recycled faster to R&D institutions. The increase in liquidity can then be utilised to ensure the viability of the business; (3) Quarterly reimbursements only expose the government to a maximum of 18 months of earlier exposure to default than the current system. Quarterly reimbursement caps could be used to constrain the credits available for reimbursement to lower government exposure to individual companies.

20. In the European Commission's (2007) comprehensive report Improving knowledge transfer between research institutions and industry across Europe, the Commission cites with approval the experimentation in the Netherlands as a good practice of incentivisation. Under the current system, contracted R&D costs are allowed to be deducted and earn R&DTI credits at a reduced rate. This is common to a number of jurisdictions around the world.
21. For example, Israel has 80 per cent of researchers employed in industry and Canada has 60 per cent employed in industry.
22. A similar recommendation was also supported by Ferris et al. (2016).
23. Empirical evidence on the effect of collaboration is scarce as there are few countries that implement specific premiums to collaboration: Belgium (through payroll tax deductions available based on the educational status of the employee (OECD, 2020)), France, Iceland, Italy, Japan and Hungary. France provides world leading incentives to both small and large businesses. Specifically, it provides a premium of 30 per cent in tax credits on top of the existing 30 per cent credit for R&D expenses when the expenses are incurred in the hiring of PhD graduates or in collaboration with research institutions. Similarly, Japan provides a credit of 20-30 per cent for research conducted as part of a collaboration (compared with a base credit rate of 6-17 per cent). Hungry provides for deductions of up to 400 per cent of the eligible collaboration expenditure. Other countries run largely parallel schemes with incentives for either direct collaboration with research institutions or the hiring of PhD graduates.
24. Furthermore, such changes in remuneration are consistent with the recent restructuring of the national assessment system of the ARC to focus research on engagement and impact. Moreover, it should be noted that industry often cites differing or divergent incentives as a primary reason for not collaborating with researchers (ISA, 2016). Innovation vouchers are already used at the state level. However, there are no federal government programs with broadly available innovation vouchers.
25. Innovation vouchers are already used at the state level. However, there are no federal government programs with broadly available innovation vouchers. State level innovation vouchers predominantly target particular industries.
26. In the UK, the "Growth Vouchers" program provided US$40 million in vouchers up to US$2,500 each to use in the marketplace for business advisors. The vouchers were assigned at random without several different trials.
27. As with the UK setting, the Netherlands distributed the innovation vouchers to SMEs at random, and performance over the short- and long-term monitored to identify causal effects of voucher allocation. Similar experimentations are being conducted throughout Europe.
28. In the European Commission's (2007) comprehensive report Improving knowledge transfer between research institutions and industry across Europe, the Commission cites with approval the experimentation in the Netherlands as a good practice of incentivisation.
29. The Miles (2015) report puts particular emphasis on the fact that CRCs, and their administration, should be led by industry rather than by academia. Without specifically recommend a process for CRC administration, we support, broadly, the recommendations of the Miles (2015) report insofar as they call for streamlined, industry led administration of CRCs to reduce incentive frictions that impacted industry use of CRCs.
30. While we have not performed a complete cost and benefit analysis of expanding funding to CRCs, returns to investment of 3:1 provide strong grounds to suspect that the net cost of investment in CRCs is likely to be minimal.
31. In recent news coverage of the Federal Government Budget, Bill Ferris called for a quadrupling of investment in CRCs, citing the overwhelming evidence of benefits provided by some of Australia's earliest CRCs. https://www.afr.com/politics/federal/budget-a-stunning-lost-opportunity-says-bill-ferris-20190403-p51aci
32. As reported in the Australian Financial Review (Smith and Gillezeau, 2018), Airtasker engaged outside consultants for advice on their claims and proceeded on the basis of that external advice.
33. For example, Israel provides special taxation regimes for software companies, the United Kingdom includes many software development activities under its taxation offset, and the Netherlands provides both for deductions for wage expenses incurred in software development and provides a special taxation regime/innovation box. Many other countries provide similar support for innovation in software. Other regimes with software development eligibility include Austria, Brazil, China, Malaysia, Mexico, South Africa, Spain, Russia, Turkey, and the United States (Deloitte, 2015).
34. As previously indicated, there is a system of Advanced Finding for those companies seeking confirmation of status before engaging in R&D activity.

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Appendix A

Table A1 — OECD Effective Subsidy Scores

		Large Loss-making		SME		SME Ranking	
Country	Year	Loss Making	Profitable	Loss Making	Profitable	Loss Making	Profitable
France	2019	0.33	0.43	0.43	0.43	1	1
Portugal	2019	0.31	0.39	0.31	0.39	3	2
Thailand	2019	-0.01	0.37	0.29	0.37	5	3
Chile	2019	0.27	0.34	0.27	0.34	6	4
Colombia	2019	0.25	0.34	0.25	0.34	9	5
Spain	2019	0.26	0.33	0.26	0.33	8	6
Canada	2019	0.10	0.13	0.31	0.31	2	7
Netherlands	2019	0.14	0.15	0.30	0.31	4	8
Lithuania	2019	0.25	0.31	0.25	0.31	10	9
Ireland	2019	0.23	0.29	0.23	0.29	12	10
Slovak Republic	2019	0.21	0.28	0.21	0.28	15	11
United Kingdom	2019	0.11	0.11	0.27	0.27	7	12
Brazil	2019	-0.01	0.27	-0.01	0.27	42	13
Korea	2019	0.02	0.02	0.21	0.26	14	14
Iceland	2019	0.24	0.24	0.24	0.24	11	15
Norway	2019	0.21	0.21	0.23	0.23	13	16
Poland	2019	0.18	0.22	0.18	0.22	19	17
Malta	2019	0.17	0.22	0.17	0.22	21	18
Slovenia	2019	0.17	0.21	0.17	0.21	22	19
Czech Republic	2019	0.15	0.21	0.15	0.21	24	20
Hungary	2019	0.18	0.20	0.18	0.20	17	21
Japan	2019	-0.01	0.17	-0.01	0.20	45	22
Australia	2019	0.07	0.10	0.19	0.19	16	23
New Zealand	2019	0.18	0.18	0.18	0.18	18	24
Austria	2019	0.17	0.17	0.17	0.17	20	25
Belgium	2019	0.14	0.15	0.15	0.16	23	26
South Africa	2019	0.13	0.16	0.13	0.16	25	27
Russian Federation	2019	0.00	0.11	0.00	0.11	41	28
Romania	2019	0.07	0.08	0.07	0.08	26	29
China	2019	0.18	0.23	0.06	0.08	27	30
Greece	2019	0.06	0.08	0.06	0.08	28	31
Mexico	2019	0.05	0.06	0.05	0.06	29	32
Turkey	2019	0.05	0.06	0.05	0.06	31	33
Sweden	2019	0.05	0.05	0.05	0.05	30	34
United States	2019	0.04	0.05	0.05	0.05	32	35
Italy	2019	0.04	0.04	0.04	0.04	33	36
Croatia	2019	0.05	0.07	0.03	0.04	34	37

Bulgaria	2019	0.00	0.00	0.00	0.00	35	38
Estonia	2019	0.00	0.00	0.00	0.00	37	39
Israel	2019	0.00	0.00	0.00	0.00	39	40
Latvia	2019	0.00	-0.01	0.00	0.00	40	41
Denmark	2019	-0.01	0.00	-0.01	0.00	44	42
Cyprus	2019	0.00	-0.01	0.00	-0.01	36	43
Finland	2019	0.00	-0.01	0.00	-0.01	38	44
Switzerland	2019	-0.01	-0.01	-0.01	-0.01	43	45
Luxembourg	2019	-0.01	-0.01	-0.01	-0.01	46	46
Argentina	2019	-0.02	-0.02	-0.02	-0.02	47	47
Germany	2019	-0.02	-0.02	-0.02	-0.02	48	48

** Table is ordered by the b-index ranking for profitable SMEs. SME definition provided by the OECD and so may not be comparable between countries.*

Source: Data from the OECD Data Repository (OECD.Stat)

RESEARCH AND DEVELOPMENT TAX INCENTIVES: IMPROVING INDUSTRY-UNIVERSITY COLLABORATION

Table A2 — R&D Spending as a % of GDP

Country	Year	R&D Spending (% of GDP)
Argentina	2017	0.56
Australia	2017	1.79
Austria	2019	3.18
Belgium	2018	2.68
Canada	2019	1.54
Switzerland	2017	3.29
Chile	2018	0.35
China	2018	2.14
Colombia	2019	0.28
Czech Republic	2018	1.93
Germany	2018	3.13
Denmark	2018	3.03
Spain	2018	1.24
Estonia	2018	1.40
Finland	2018	2.76
France	2018	2.19
United Kingdom	2018	1.73
Greece	2018	1.18
Hungary	2018	1.53
Ireland	2018	1.00
Iceland	2018	2.04
Israel	2018	4.94
Italy	2018	1.43
Japan	2018	3.28
Korea	2018	4.53
Lithuania	2018	0.94
Luxembourg	2018	1.21
Latvia	2018	0.64
Mexico	2018	0.31
Netherlands	2018	2.16
Norway	2018	2.06
New Zealand	2017	1.35
Poland	2018	1.21
Portugal	2018	1.36
Romania	2018	0.50
Russian Federation	2018	0.98
Singapore	2018	1.84
Slovak Republic	2018	0.84
Slovenia	2018	1.95
Sweden	2018	3.32
Turkey	2018	1.03
Chinese Taipei	2018	3.46
United States	2018	2.83
South Africa	2016	0.82

Source: Data from the OECD Data Repository (OECD.Stat)

Table A3 — Government funding of BERD

Country	Tax Incentives (% of GDP)	Direct funding (% of GDP)	Ratio
Netherlands	0.16	0.02	6.57
Australia	0.14	0.02	6.34
Italy	0.16	0.03	5.25
Japan	0.12	0.02	5.24
Lithuania	0.02	0.00	4.94
Belgium	0.30	0.06	4.72
Portugal	0.12	0.03	4.14
Malta	0.03	0.01	3.56
Ireland	0.15	0.04	3.51
France	0.28	0.12	2.45
United Kingdom	0.21	0.09	2.41
Canada	0.13	0.06	2.31
Austria	0.16	0.08	2.02
Slovenia	0.11	0.07	1.44
Turkey	0.07	0.05	1.34
Norway	0.13	0.10	1.22
China	0.07	0.06	1.21
Iceland	0.11	0.12	0.86
Korea	0.13	0.16	0.84
Slovak Republic	0.01	0.01	0.83
Czech Republic	0.05	0.08	0.63
Spain	0.04	0.06	0.61
Chile	0.01	0.02	0.59
Denmark	0.02	0.04	0.51
Hungary	0.06	0.13	0.43
Latvia	0.00	0.01	0.30
Russian Federation	0.10	0.38	0.27
Mexico	0.00	0.01	0.19
Sweden	0.01	0.11	0.11
New Zealand	0.01	0.09	0.10
Argentina	0.00	0.00	0.09
Poland	0.01	0.09	0.06
Bulgaria	0.00	0.01	0.00
Switzerland	0.00	0.02	0.00
Cyprus	0.00	0.00	0.00
Germany	0.00	0.07	0.00
Estonia	0.00	0.03	0.00
Finland	0.00	0.06	0.00
Croatia	0.00	0.01	0.00
Luxembourg	0.00	0.05	0.00

Source: Data from the OECD Data Repository (OECD.Stat)

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Table A4 — Change in BERD

Country	2010 BERD/GDP	2017 BERD/GDP	Change	Rank
Korea	3.32	4.29	0.98	1
Israel	3.94	4.82	0.88	2
Belgium	2.06	2.66	0.60	3
Switzerland**	2.71	3.29	0.58	4
Greece	0.60	1.13	0.53	5
Czech Republic	1.34	1.79	0.45	6
Norway	1.65	2.10	0.45	7
China	1.71	2.12	0.40	8
Germany	2.73	3.07	0.34	9
Austria	2.73	3.05	0.32	10
Poland	0.72	1.03	0.31	11
Netherlands	1.70	1.98	0.28	12
Slovak Republic	0.61	0.89	0.27	13
Sweden	3.17	3.36	0.19	14
Hungary	1.14	1.33	0.19	15
Turkey	0.80	0.96	0.16	16
Italy	1.22	1.37	0.15	17
Denmark	2.92	3.05	0.13	18
Lithuania	0.79	0.90	0.11	19
New Zealand*	1.25	1.35	0.09	20
United States	2.74	2.81	0.08	21
Japan	3.14	3.21	0.07	22
Colombia	0.19	0.26	0.07	23
Russian Federation	1.05	1.11	0.06	24
Romania	0.46	0.50	0.05	25
United Kingdom	1.65	1.68	0.03	26
Chile	0.33	0.36	0.03	27
France	2.18	2.20	0.02	28
Argentina	0.56	0.56	-0.01	29
Latvia	0.61	0.51	-0.10	30
Spain	1.36	1.21	-0.15	31
Canada	1.83	1.67	-0.16	32
Mexico	0.49	0.33	-0.17	33
Slovenia	2.05	1.87	-0.18	34
Portugal	1.54	1.32	-0.22	35
Luxembourg	1.50	1.27	-0.23	36

Estonia	1.57	1.28	-0.29	37
Ireland	1.59	1.24	-0.35	38
Australia	2.18	1.79	-0.40	39
Iceland*	2.60	2.10	-0.49	40
Finland	3.71	2.73	-0.97	41

** Based on 2009 data for 2010 values.*
*** Based on 2008 data for 2010 values.*

Source: OECD Data Repository (OECD.Stat)

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