

Translating research for economic and social benefit: country comparisons

9

PROJECT

FINAL REPORT

AUSTRALIAN ACADEMY
OF THE HUMANITIES
AUSTRALIAN
ACADEMY OF SCIENCE
ACADEMY OF THE SOCIAL
SCIENCES IN AUSTRALIA
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Acronyms

A*STAR	Agency for Science, Technology and Research	CRADAs	Cooperative Research and Development Agreements
A-STEP	Adaptable and Seamless Technology transfer Program	CRC	Cooperative Research Centre
AAH	Australian Academy of the Humanities	CSIRO	Commonwealth Scientific and Industrial Research Organisation
ABS	Australian Bureau of Statistics	EPSRC	Engineering and Physical Sciences Research Council (UK)
ACOLA	Australian Council of Learned Academies	ERA	Excellence in Research Australia
AHA	Academy of Humanities and the Arts	ERC	Engineering Research Centers Program (US)
AIST	National Institute of Advanced Industrial Science and Technology (Japan)	ESVF	Early Stage Venture Fund
ANZSRC	Australian and New Zealand Standard Research Classification	EU	European Union
ARC	Australian Research Council	EWG	Expert Working Group
AUTM	Association of University Technology Managers (US-based)	FINEP	Financiadora de Estudos e Projetos/Funding Authority for Studies and Projects (Brazil)
ATSE	Australian Academy of Technological Sciences and Engineering	FoR	Field of Research
ATTP	Alliance of Technology Transfer Professionals	FTTA	Federal Technology Transfer Act
BCA	Business Council of Australia	GAO	Government Accountability Office (US)
BERD	Business Expenditure on Research and Development	GERD	Government Expenditure on Research and Development
BIS	Department of Business, Innovation and Skills (UK)	GDP	Gross Domestic Product
BL-NCE	Business-Led Networks of Centres of Excellence (Canada)	GOVERD	Government Expenditure on Research and Development
BMBF	Bundesministerium für Bildung und Forschung/Federal Ministry for Education and Research (Germany)	GRI	Government Research Institute
BMWi	Bundesministerium für Wirtschaft und Energie/Federal Ministry of Economics and Energy (Germany)	GTS	Godkendt Teknologisk Service/Advanced Technology Group (Denmark)
CFI	Canadian Foundation for Innovation	HASS	Humanities, Arts and Social Sciences
CIHR	Canadian Institutes of Health Research	HEI	Higher Education Institutions
CORFO	Corporación de Fomento de la Producción de Chile/Production Development Corporation (Chile)	HEIF	Higher Education Innovation Fund
CR&D	Collaborative Research and Development	HERD	Higher Education Expenditure on Research and Development
		ICT	Information and Communications Technology
		IFD	Innovationsfonden/Innovation Fund Denmark
		IOF	Innovation Ohio Loan Fund (US)
		IP	Intellectual Property
		IPRIA	Intellectual Property Institute of Australia
		IPR	Intellectual Property Rights

IRAP	Industrial Research Assistance Program (Canada)	PRIME	Primeira Empresa Inovadora (Prime, First Innovative Enterprise)
IUCRC	Industry-University Cooperative Research Centers Program (US)	R&D	Research and Development
I2I	Idea to Innovation	RCUK	Research Councils UK
JST	Japan Science and Technology Agency	REA	Research Engagement for Australia
KODIT	Korea Credit Guarantee Fund	SATT	Sociétés d'Accélération du Transfert de Technologies/ Technology Transfer Acceleration Companies (France)
KTP	Knowledge Transfer Partnerships	SBIR	Small Business Innovation Research Program
LES	Licensing Executives Society Australia and New Zealand	SEBRAE	Serviço Brasileiro de Apoio às Micro e Pequenas Empresas/ Brazilian service of assistance to micro and small enterprises
MIT	Massachusetts Institute of Technology	SHOK	Strategisen huippuosaamisen keskittymät/Strategic Centres for Science, Technology and Innovation (Finland)
MoF	Ministry of Finance (China)	SIGNO	Schutz von Ideen für die Gewerbliche Nutzung/Protection of Ideas for Commercial Use (Germany)
MoST	Ministry of Science & Technology (China)	SME	Small and Medium sized Enterprise
NAS	National Academy of Sciences (US)	SPIR	Strategic Platforms for Innovation and Research (Denmark)
NASA	National Aeronautics and Space Administration (US)	SSHRC	Social Sciences and Humanities Research Council (Canada)
NCE	Networks of Centres of Excellence of Canada	STTR	Small Business Technology Transfer Program (US)
NCRIS	National Collaborative Research Infrastructure Strategy	TSB	Technology Strategy Board (UK)
NEDO	New Energy and Industrial Technology Development Organisation (Japan)	TFP	Total Factor Productivity
NHMRC	National Health and Medical Research Council	THC	Technology Holding Company
NIC	National Innovation Challenge (Singapore)	TLO	Technology Licensing Office
NRC	National Research Council (Canada)	TTO	Technology Transfer Office
NRF	National Research Foundation (Singapore)	TULI	Creating Business from Research (a Tekes program)
NSERC	Natural Science and Engineering Research Council (Canada)	UK	United Kingdom
NSF	National Science Foundation (US)	US/USA	United States/United States of America
NUPLITEC	Núcleo de Patentamento e Licenciamento de Tecnologia/ Patents and Technology Licensing Unit (Brazil)	VINNOVA	Sweden's innovation agency
OCS	Office of the Chief Scientist (Israel)	VTT	Technical Research Centre of Finland
OECD	Organisation for Economic Cooperation and Development	ZIM	Zentrales Innovationsprogramm Mittelstand/The Central Innovation Program for SME (Germany)
PFRI	Public Funded Research Institute		
PPP	Purchasing Power Parity		



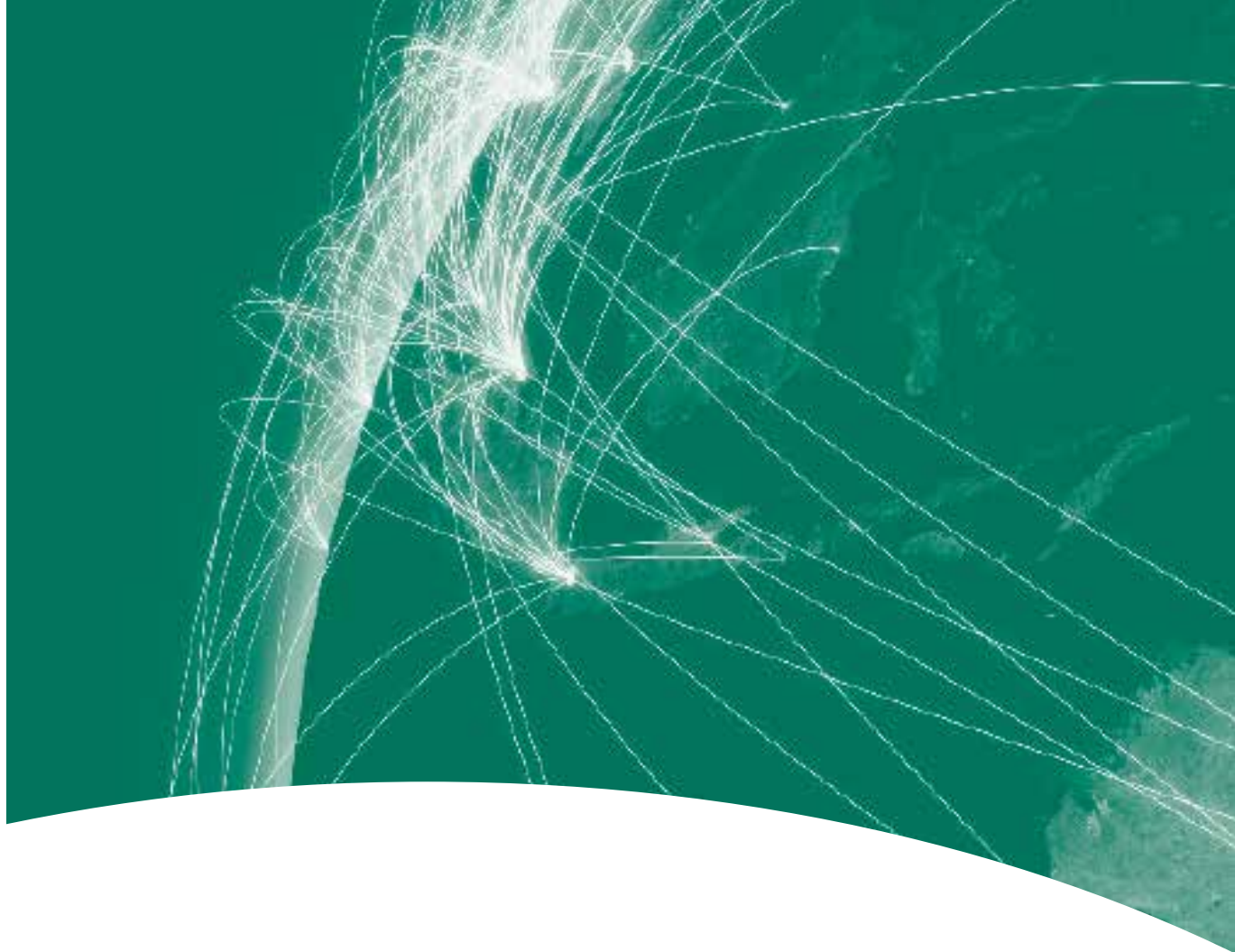
Project aim and objectives

Aim

Analyse international approaches to lifting research translation and business-researcher collaboration in countries deemed to be leading practice, and examine their applicability for Australia.

Objectives

- Review approaches in selected countries and Australia in regard to commercialisation of research and support for collaboration, including a comparison of what works and why. The project will also review examples of what has not worked and look at underlying reasons.
- Examine how successful countries measure the impact of research in terms of translation and engagement.
- Determine the common barriers to research translation internationally, and how have these been successfully overcome in other countries (e.g. access to finance).
- Analyse the applicability of international models to the Australian context.



Questions and themes to be addressed

- Compare models for enhancing collaboration between researchers and between researchers, business, government and other parties such as not-for-profit organisations. What are the benefits/costs of each model and what are the cultural elements that impact on these models?
- Examine Australian models for collaboration between organisations and businesses engaged in research.
- Examining the extent to which research collaboration programs can increase the translation of public sector research. What types of businesses and industries are being engaged? What outcomes are accruing?
- Evaluate the success of overseas programs that encourage industry-driven research collaboration and examine their potential applicability in Australia. What would be the outcome and/or benefits if specific measures were taken up in Australia?
- Incentivising the utilisation of intellectual property.
- Building a risk-tolerant business culture, and cultural aspects that affect translation in different countries.
- Government-led initiatives put in place to build a business innovation culture.
- Examining how institutional and business collaboration contributes to the application and translation of research outcomes.
- How is success measured in each country/by each model/differences across sectors (design, creative industries, etc.)?

Countries to be examined

- European Union (Finland, Denmark, Sweden, Germany, United Kingdom)
- Israel
- United States and Canada
- South Korea, Japan, Singapore, China
- Brazil and Chile
- Australia



Executive summary

The effective translation of public sector research lies at the core of Australia's future competitiveness and prosperity. Research translation also provides societal and cultural benefits. This project has explored ways in which the translation of public sector research in Australian can be enhanced.

Boosting the ways in which new ideas are disseminated and applied is an important priority in a modern knowledge-based economy, requiring increased levels of collaboration between researchers, businesses, not-for-profits and the government sector. To achieve these outcomes, Australia can leverage the skills and knowledge in public sector research institutions through collaborative research, driving closer engagement with other parties.

Australia is undergoing a necessary economic transformation, transitioning from high dependence on natural resources to a knowledge-based economy. In order to secure Australia's future, this transformation

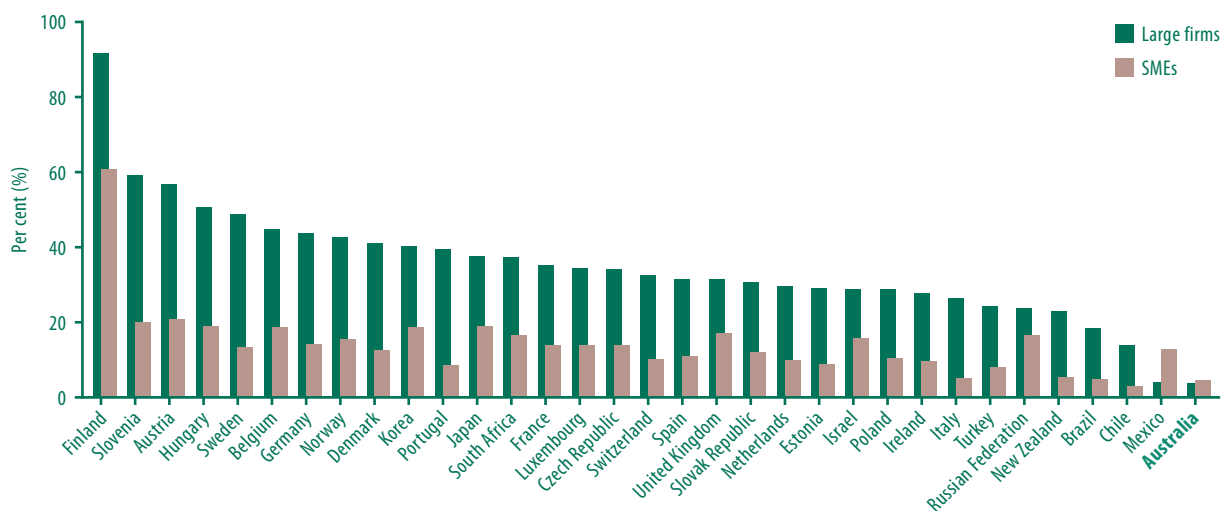


needs to be driven by innovation. Innovation relies on a number of factors, including strong engagement and collaboration between public sector researchers, business and other external counterparts. Improving this collaboration requires changes in policies and programs. Providing well targeted and funded incentives for each of the parties involved will not only increase research translation but will also bring about the cultural change necessary to make it a routine feature of research and business practice.

This project has found that, to be fully effective, policies and programs to encourage increased research translation need to be part of a stable national innovation strategy and administered by an independent agency.

This project has reviewed measures in fourteen countries and Australia to encourage and facilitate research translation and application. Selected measures to facilitate collaboration between researchers, businesses and other organisations have been analysed, focusing on government strategies as well as industry, institutional and sectoral approaches. The report has considered how Australia's research translation performance can be improved. A number of principles and leading practices have been identified, based on the policies and programs of countries with a successful track record in research translation.

Innovative firms collaborating with higher education/public research institutions



Source: OECD (2013b), DOI: <http://dx.doi.org/10.1787/sti_scoreboard-2013-graph110-en>.

Public sector research is a critical part of Australia's innovation system. Australian researchers perform well by international standards and some Australian universities are among the best in the world. However, no Australian university is ranked in the top 100 innovative universities worldwide. Engagement and research translation on the part of public sector researchers in Australia is low by OECD standards. This is despite Australian public R&D expenditure as a percentage of GDP being slightly above the OECD country average.

By comparison with other OECD countries, Australia's research translation problems include:

- low collaboration between public sector researchers and business
- many public sector researchers not actively seeking involvement in translation activities
- a lack of demand on the part of business, industry and other potential users who are not motivated to engage
- a lack of effective intermediaries to facilitate links between public sector researchers and external parties.

This study has identified a number of reasons for these problems, including the absence of effective institutions, relationships and incentives. An analysis of Australian policies and programs commissioned for this report demonstrates that measures to support the translation of public

sector research in Australia are fragmented, uncoordinated and under-resourced.

This report draws on the experiences of fourteen countries. These countries have been selected because of their strong performance in research translation, their novel approaches to encouraging translation and, in some cases, similarities with Australia. Most of the translation-related measures that have been selected for particular analysis have a strong record of success over a number of years, have been favourably reviewed, and are considered to be appropriate and leading-practice models that could be adopted in Australia.

Based on analysis of research translation policies and measures that have been implemented in the countries reviewed, this report provides the following findings:

Finding 1. Australia can improve the translation of public sector research for economic and social benefit by establishing a stable suite of well-funded and sustainable, leading-practice measures

While Australia's measures for encouraging the translation of public sector research have evolved over the last ten years, this has occurred in a piecemeal manner, involving a number of state and Commonwealth agencies offering measures,

generally with very modest funding. As noted above, Australia's measures to support the translation of public sector research have been found to be inadequate. They are also often short term in nature. In many cases there has been inadequate reporting of program outputs and minimal evaluation of achievement.

This report provides a number of examples where stable, well-designed and funded measures in other countries have created jobs, increased business turnover and provided other benefits. The project has found that leading practice measures from other countries can be used to develop a carefully targeted suite of incentives to encourage Australian researchers, universities and business and other parties to work together.

Many of the most effective measures discussed in this report have operated over many years, continuing to maintain core objectives, branding and administrative arrangements. This stability has provided certainty for researchers, public sector research organisations and external counterparts. This report provides a number of examples, including the United States' Small Business Innovation Research Program and the Canadian NSERC's Engage Grants, where stable, well-designed and funded translation incentives have created jobs, increased business turnover and provided societal benefits.

The effectiveness of incentives to encourage research translation described in this report has been demonstrated through evaluations and reviews. Incentives need to recognise the breadth of potential interactions between public sector researchers and other parties. They also need to accommodate the range of responsibilities and accountabilities within agencies at different levels of government.

Finding 2. Supporting SMEs and start-ups with high growth potential will help to increase the translation of public sector research in Australia

Small and medium-sized enterprises (SMEs) are important receptors for the translation of public sector research. They are often able to take up

and adapt new ideas quickly. SMEs with high growth potential are the target for many of the government measures reviewed for this project. They are an important source of future jobs and economic growth. However, compared with larger firms, SMEs are often time and resource poor. They also often do not know where to go to find help, or to seek research outcomes, from universities. There are market failure arguments that are specific to SMEs and justify these companies getting special attention. Programs such as Germany's ZIM Program and Brazil's First Innovation Program (PRIME) are examples of effective measures that target research translation at business.

Start-up and spin-out companies from public sector research institutions represent a small proportion of research translation. However, evidence shows that they are an important source of new business opportunities and jobs (Anyadike-Danes *et al.*, 2013). Countries as diverse as Canada and Finland both have well-established leading practice measures to assist such companies. Adopting some of these approaches in Australia will help ensure that we grow a new generation of technology-based firms to follow in the footsteps of Cochlear, Resmed, and CSL—all of which had public sector origins.

Finding 3. Australia can make greater use of direct support measures for business innovation to increase research translation

Firms that undertake R&D are more likely to become involved in the translation of public sector research. The project has found that Australia is overly reliant on indirect support for business R&D through the R&D tax incentive. Shifting the balance of government support for business innovation to greater use of direct measures such as grants, loans and procurement contracts would allow a more focused and targeted approach to support for research collaboration and translation.

Loans, which in other countries are increasingly combined with grants, are becoming a significant

source of finance for start-ups and SMEs with high growth potential. Australia can learn from other countries in this regard. International examples of loan schemes include The Zero Interest Rate Program (JURO ZERO) in Brazil, Korea's Industrial Technology Development Loan Fund and Germany's ERP Innovation Program.

Finding 4. Australia's business R&D tax incentive could be adjusted to encourage collaboration with public sector researchers

A number of the countries reviewed are using R&D tax incentives to encourage collaboration with public sector research institutions. Countries that have adopted this approach have higher rates of business collaboration with public sector research institutions. Examples of such countries include Denmark and Chile. This suggests that a more favourable incentive for such collaboration is an effective incentive for business. Australia's R&D tax incentive could be adjusted to provide companies with a greater benefit for collaborative work with public sector researchers.

Finding 5. Increasing funding for research collaboration programs and requiring rigorous engagement between the parties involved will increase research translation in Australia

There is a need to reform Australian research collaboration programs, such as ARC's Linkage Programs, by increasing funding and adopting the leading grant administration practices of programs reviewed for this report. To obtain optimal benefit from these programs, grant recipients should be required to adopt a milestone based approach to project management, develop IP strategies, and ensure active collaboration between all parties. For larger projects, grant payments should be made against the achievement of milestones.

At the same time, government should be encouraging universities to shift from project-based collaboration to building more substantial

longer-term partnerships with external parties (including business and not-for-profits).

Finding 6. Measures to encourage public sector researcher engagement can be structured in ways that create opportunities for those in the humanities, arts and social sciences

Measures to encourage effective research translation should recognise the capacity of HASS researchers to deliver national benefit across a range of areas, including in the export of services, social enterprise innovation, and evidence-based social policy that strengthens the social fabric and supports those in disadvantaged positions. As the opportunities and challenges for translating research differs across the HASS and STEM disciplines, consideration should be given to developing specific measures to encourage HASS engagement and collaboration with both the public sector and with industry, as have been developed in some of the countries featured in this study. At a minimum, it is important to ensure that HASS researchers are not excluded from generally available measures to encourage public sector researcher engagement with external parties.

Finding 7. Australia can increase research translation through the placement of students and new graduates in business and other organisations

Programs that support the project-based placement of students and new graduates within external organisations will help to transfer new creative and technical skills to the business, government and not-for-profit sectors. Work integrated learning placements can also help build relations between universities and external parties that can lead to future collaborations.

The UK's Knowledge Transfer Partnerships Program has been identified as a leading practice measure to increase links between universities and business, to translate research outcomes

through the knowledge and skills of new graduates, and to increase the recruitment of science and engineering graduates by business. Australia could establish a similar program, with resources and commitment on a scale comparable to the UK. Under such a program, placements could involve students and new graduates from all disciplines including the social sciences, humanities and the arts.

Finding 8. Increased assistance for collaborative research will enhance translation in Australia

Research collaboration between public sector researchers and external parties is an important means of transferring knowledge and skills. Many of the countries reviewed for this project have programs that are similar to Australia's Cooperative Research Centres (CRC) Program, designed to bring together public sector researcher, industry and other partners. Most other countries provide this type of support on a larger and more generous scale than Australia. Australia needs a range of university-business collaboration models that includes research centres, networks, clusters, hubs, precincts, and better-funded CRC and Linkage Programs.

Finding 9. Providing targeted incentives to Australian universities is a proven method of increasing their engagement with external parties

Incentives to increase university engagement need to recognise the breadth of interactions between universities and external parties, which go well beyond commercialisation of research. Other forms of engagement are also important and can involve all disciplines, including the humanities, arts and social sciences.

Introducing metrics for university engagement with external parties, and rewarding this engagement has played a key role in increasing research translation in the UK. The UK is a leading practice country in terms of engagement incentives for universities. It provides support for

university engagement through Higher Education Innovation Fund (HEIF). The evidence shows that HEIF has generated jobs and economic growth. Another UK initiative, requiring *Pathways to Impact* statements for research grant applications, is also bringing about change in public sector researcher attitudes to engagement with external parties.

Finding 10. Measures to support the financing of commercial outcomes from public sector research would address a major gap in Australia's innovation system

Many of the countries examined in this report have adopted measures to help the outcomes of public sector research find their way to the market. Examples include Singapore's Early Stage Venture Fund, Japan's A-STEP and Germany's SIGNO Program. Australia lacks sources of capital to enable commercialisation of outcomes from public sector research. Governments in other countries such as Israel and Denmark facilitate or provide such capital. The US Small Business Innovation Research Program is another example.

Programs that offer combinations of grants and loans to SMEs with strong growth potential should also be considered. Finland's Tekes has a multi-phase program to support young innovative companies. This is a leading practice example of combining grants and loans.

Finding 11. Greater use of innovation intermediaries would enhance collaboration and increase research translation in Australia

Innovation intermediary organisation can facilitate the flow of public sector research skills and knowledge to SMEs. They can interpret research findings for businesses and articulate to researchers the needs of businesses in ways each of these parties cannot. However they need to be adequately funded if they are going to make a difference and it will take some time for these organisations to have measurable impact. As such, bipartisan support for their development

and operation is essential to ensure that stable funding and support for these organisations is provided. The UK's Catapult Centres seek to align industry, university and government needs. Scotland's Interface Program provides another leading practice example of an intermediary organisation.

Finding 12. Australia can emulate leading countries' consistent support of successful research translation by adopting a coherent national strategy for innovation and establishing a national innovation agency to manage it

Countries achieving high levels of public sector research translation provide a sound institutional context for this activity by making it a key element of a national innovation strategy. Most leading practice countries have well-resourced and coordinated innovation strategies, which provide a reference point to guide the selection of policy and program options. Such strategies can define which measures are best addressed at a national level and which are better delivered by sub-central government. They can also help to minimise overlap and duplication between levels of government.

In many of the countries reviewed, the delivery of national innovation strategies is the responsibility of an independent agency, which operates at arm's length from government. Australia can look to successful innovation agencies, such as Finland's Tekes, Sweden's VINNOVA and Innovate UK as models for an Australian innovation agency.

Initiatives to enhance research translation need to be multifaceted, incentivise multiple actors and work on multiple levels. When these initiatives are part of a national innovation strategy and are based on a coherent set of policies, they can achieve real results. The establishment of a national innovation strategy and an implementation agency needs bipartisan support.

Finding 13. Independent reviews and evaluations of research translation measures are necessary to ensure that they are achieving their objectives

The project has found that leading practice countries regularly commission independent evaluations of innovation and research translation measures and make the evaluations public. For example the UK's Knowledge Transfer Partnerships Program has undergone a number of independent evaluations over its 40-year existence. Program reviews can demonstrate the benefits of successful measures. Israel's Magnetron Program underwent an independent review in 2009, which found that around 80 per cent of projects involved a high level of innovation and achieved breakthroughs or new knowledge. In leading practice countries, adjustments to policies and programs are informed by such evaluations. Australia should use independent reviews and evaluations to ensure the continual effectiveness of research translation measures.

Finding 14. Streamlining internal university policies and procedures can improve university engagement with business and other external parties

Many universities in other countries have simplified and streamlined arrangements for collaboration between businesses and university faculties, research centres and staff. Australian universities should 'fast-track' approval procedures, review of delegations, and appoint executive staff with business experience to facilitate engagement with external parties.

Finding 15. Assisting the development of research translation and entrepreneurial skills in Australia's public sector research institutions will improve their performance

Several countries that have been reviewed for this project have provided targeted assistance to develop research translation skills in public sector research institutions. For example, Chile's Program to strengthen human capital for technology transfer is improving the performance of research commercialisation in its research institutes and universities. Such skills development should not be limited to university technology transfer office staff.

Providing university students with opportunities to develop entrepreneurial skills as part of their studies is a means of increasing interest in start-up company formation. Germany for example, developed The Start-ups from Science (EXIST) initiative to improve the entrepreneurial environment at universities and research institutes. Government can assist public sector research institutions by providing support for innovation contests, start-up programs (including incubators and accelerators), internships and placements, and innovative workspaces.

This report provides an important evidence base for the development of new policy measures that can be used to increase the translation of Australian public sector research for economic and social benefit. Many of the examples provided in the report have been found to generate significant benefits.



1

Introduction

Summary

This Chapter describes the purpose of the report and summarises the methodology used to produce it. It explains how the project's aim and objectives have been interpreted. The report provides information on the background to the project and discusses reasons for encouraging the translation of public sector research. It provides a conceptual framework which places research translation in an innovation system context. Finally, the structure of the report is explained.

This report examines a range of measures used by selected countries to encourage the translation of public sector research. The information and data on which this discussion is based has been largely provided by specially commissioned country reports. These reports have been supplemented with information drawn from a review of the literature.



The countries reviewed in this project are of relevance for a number of reasons, including:

- Canada, the USA, Germany and Brazil, like Australia, have federal systems of government and provide an opportunity to examine measures at different levels of government.
- The economies of Chile, Brazil and Canada, again like Australia, include strong agriculture and mining sectors.
- The economies of Denmark, Finland, Sweden, Germany and Israel have devoted considerable effort over a number of years to build a culture, attitudes, structures and support programs to nourish research translation and application.
- Countries that provide measures similar to those currently available in Australia, such as Canada and the UK are of interest in order to make comparisons.
- Countries such as Israel, Germany, Singapore and Brazil have adopted approaches that are not available in Australia and could be useful.
- The UK has a higher education system similar to that of Australia, making that country of particular interest.

1.1 How the project aim and objectives have been interpreted

This report addresses the need for Australia to increase the dividend from the considerable investment in publicly funded research. This can be achieved not only by maintaining and supporting a flow of high quality research, but also by constructing effective and efficient pathways between researchers and their ideas and those in a position to apply them to economic and social benefit.

The term ‘translation of research’ has been interpreted broadly by the Expert Working Group (EWG). For example, measures that encourage engagement or collaboration between public sector researchers and external parties have been included because these activities are likely to lead to the translation of knowledge based research. This report makes references to ‘knowledge transfer’, however this term does not adequately capture the dynamics of interchange between public sector researchers and external parties. A more appropriate term may be ‘knowledge exchange’—a process that brings together researchers, users of research and wider groups to exchange ideas, evidence and expertise.

The term ‘public sector’ in this report includes research-performing organisations which derive the majority of their research funding from public sources. In Australia, this includes universities and government research laboratories such as CSIRO. It may also include some medical research institutes.

The term ‘engagement’ is defined as knowledge-related collaboration by university researchers with external parties (Perkmann *et al.*, 2013). This can take a variety of forms (see Figure 1.1). ‘Research translation’ is considered as a process through which knowledge is used or applied to achieve outcomes. ‘Research collaboration’ is a means of providing and expanding the potential opportunities for translation. ‘Research commercialisation’ implies specific realisation of revenue from knowledge or research findings,

arising from them being incorporated in new products or services (OECD, 2013a). The mechanisms to achieve this (e.g. patenting, licensing, start-up ventures) are well established.

It needs to be recognised that research commercialisation, which has been the subject of much attention in recent years, is a relatively minor component of research translation (Abreu *et al.*, 2009). Most research translation occurs through engagement, diffusion and adoption.

Figure 1.1 illustrates the different forms of engagement by UK academics (who according to OECD data are more engaged with industry than their Australian counterparts—see Figure 1.6) (Perkmann *et al.*, 2013). What is evident from this chart is the wide range of types of interactions, and the relatively small proportion that can be considered ‘commercialisation’ activities.

However, that does not imply that there cannot be economic outcomes from research translation. For example, translation can occur when a company hires a new graduate who brings knowledge based on their research experience, when a leading practice model is diffused to a large number of users in an atomistic industry like agriculture, or when the findings of a collaborative research exercise assist in making incremental improvements to a product or process.

Considerable social benefits can also arise from research translation. Translational social science, for example, is a well-developed research area with evidence-based social policy at its core. Research in the humanities, arts and social sciences has capacity to deliver social and economic benefits across a range of areas, including through social enterprise innovation, in health, education, social inclusion, the public sector, national security and understanding regional markets for services exports. The research translation challenges for HASS disciplines in Australia differ somewhat from that of STEM. Further work is needed to understand the social and economic benefits that can flow to the nation through improved translation pathways for HASS researchers, as well as the

social and public benefits of STEM research. In the short term, the programs identified in the report to improve knowledge exchange or translation should encourage participation of researchers across all disciplines.

In this project we have given particular attention to research translation for economic benefits. However much of the analysis applies to all forms of translation, recognising that benefits may flow to public sector researchers, their employers and the external parties involved in translation.

For this project, the EWG has reviewed approaches to translation of research and support for collaboration in fourteen countries. Some have well-established and respected innovation systems, while others are still in development.

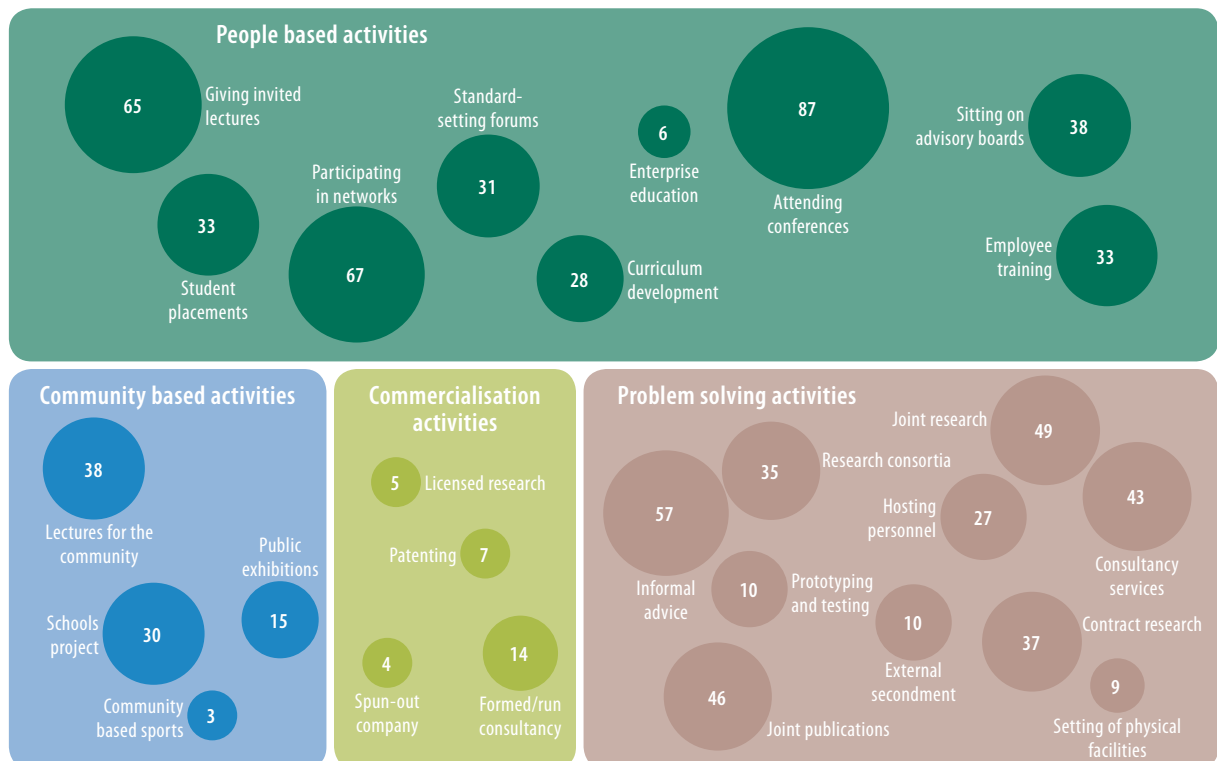
Understanding the rationale and the mechanisms for accomplishing high levels of public-private collaboration in top performing countries and the attributable outcomes for the economy, society and the environment are of particular interest. Their applicability for adoption in Australia has been analysed.

1.2 Background to this project

Recent work, including another ACOLA Securing Australia's Future report (Bell *et al.*, 2014) and the Business Council of Australia's report on building Australia's competitiveness (BCA, 2014), has identified an urgent need to improve the translation of Australia's research into economic and other benefits. In a modern knowledge-based economy, boosting the ways in which new ideas are applied in practice is an important priority and can be facilitated by measures such as increasing the levels of collaboration between researchers, businesses, not-for-profit, and government sectors. There is the opportunity for Australia to leverage the skills and knowledge in universities through sponsored research, bringing about closer collaboration between publicly funded researchers, industry, government and the community.

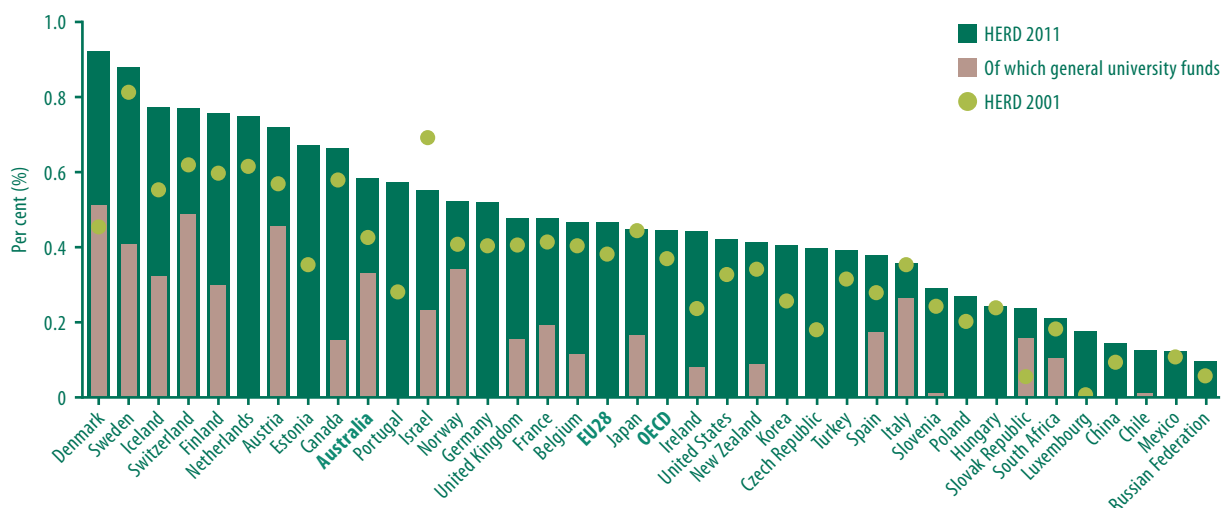
Countries that perform strongly with regard to collaboration between business and publicly funded research organisations have shown that this can improve the translation of research and

Figure 1.1: Percentages of UK academics reporting external interactions



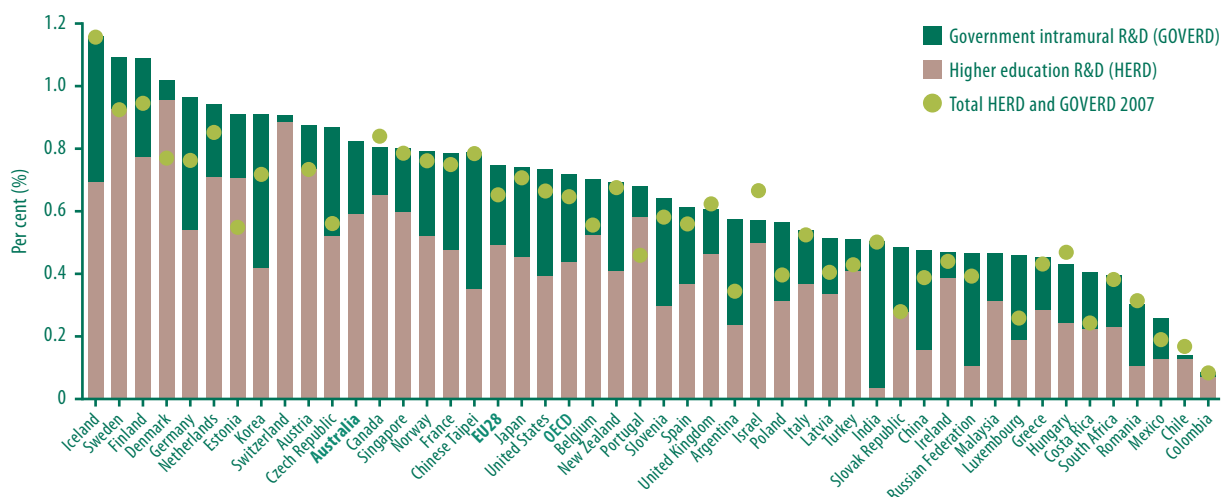
Source: Hughes and Kitson (2012).

Figure 1.2: Higher education expenditure on R&D, 2001 and 2011



Source: OECD at <<http://dx.doi.org/10.1787/888932906293>>.

Figure 1.3: Public R&D expenditure by type



Source: OECD (2015d).

maximise beneficial outcomes (Bell *et al.*, 2014). The effective translation of research lies at the core of Australia's future competitiveness and prosperity (ATSE, 2015).

Australia's higher education research spending is above the OECD average. Figure 1.2 shows higher education expenditure on R&D (HERD) as a percentage of GDP.

Australian public sector expenditure on research and development (R&D) is also strong. Figure 1.3 presents Higher Education R&D (HERD) and government expenditure on R&D (GOVERD).

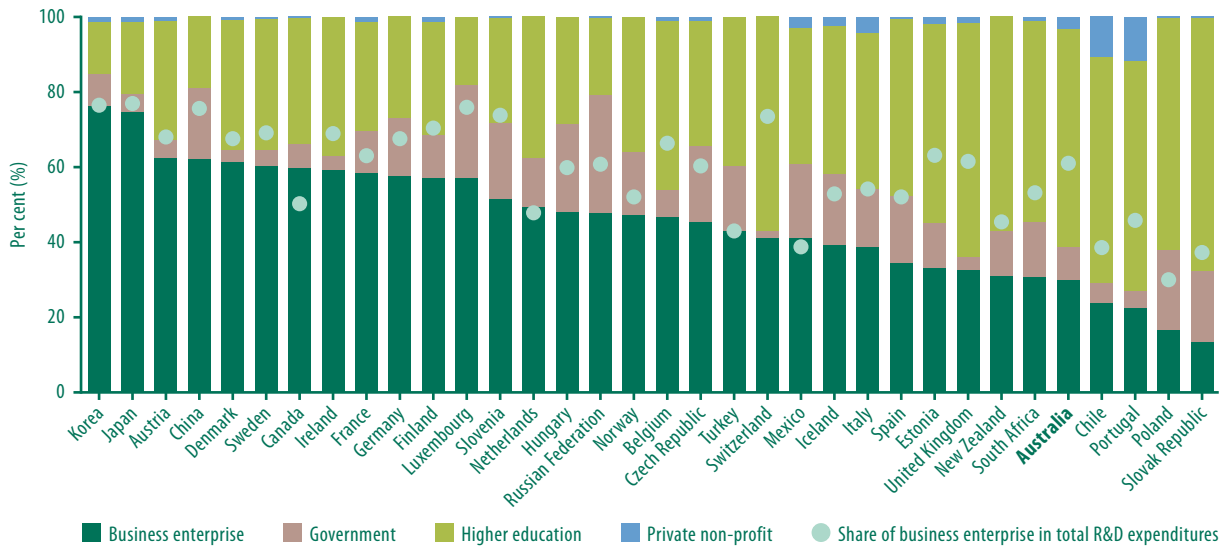
Most of Australia's research personnel are employed in the public sector (see Figure 1.4).

The above figures show that public sector research is a major part of Australia's research

system. This makes it particularly important that we give attention to the translation of public sector research into economic and social benefits. However the efficient translation of research is not without its challenges.

One of the challenges for Australian public sector researchers is finding a firm with which to engage. The OECD data shows that Australia has relatively few R&D-performing firms (see Figure 1.5). These firms would be expected to be the most likely to partner with public sector research organisations, and partnerships between public sector researchers and firms are more likely to succeed when the firm has its own personnel engaged in R&D. Translation between a researcher and a user requires that they understand each other's language.

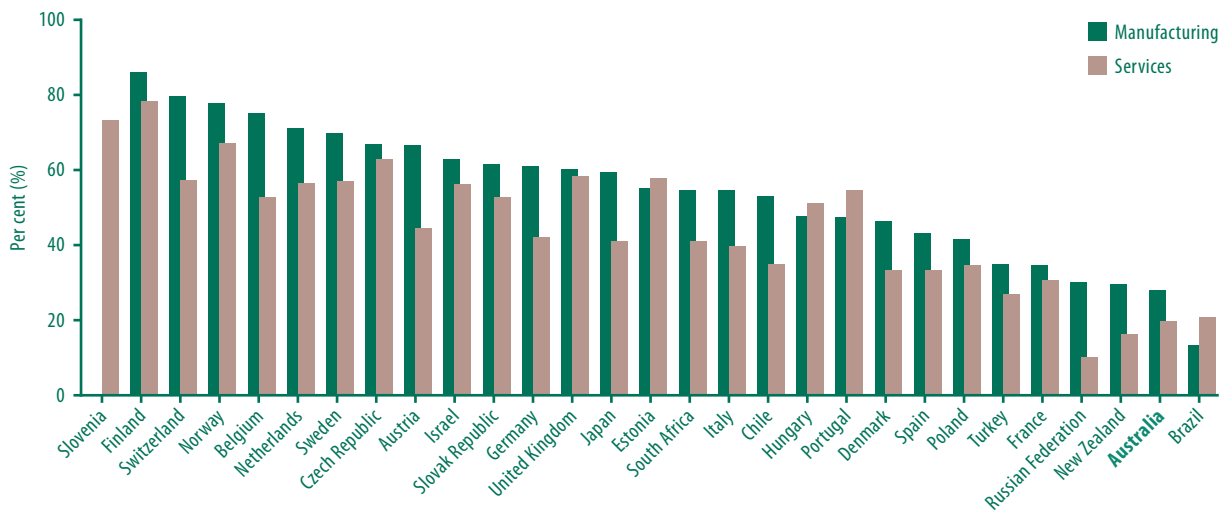
Figure 1.4: Proportion of research personnel in business, higher education and government



Note: As a percentage of total researchers, full time equivalent Data is for 2011 or nearest available year.

Source: OECD (2013b), DOI: <http://dx.doi.org/10.1787/sti_scoreboard-2013-graph86-en>.

Figure 1.5: R&D-active firms, manufacturing and services, 2008–10



Source: OECD (2013b), DOI: <http://dx.doi.org/10.1787/sti_scoreboard-2013-graph170-en>.

It should also be recognised that in many sectors, R&D is often not a formally recognised activity. As such, care has to be taken that innovation-oriented investments in sectors that could benefit from connections with the research base have modes of engagement that are not solely based on a narrow assessment of a firm’s R&D capability; measures of absorptive capacity may be more appropriate.

Low levels of collaboration by Australian business with public research institutions appear to be reflected in low levels of collaboration between firms. This lack of collaborative activity

on the part of businesses makes it difficult for universities to find partners in the business sector. It also suggests that Australian firms are not well integrated into supply chains which, given the importance of supply chains to business sustainability (Bell *et al.*, 2014), could also be a problem.

Australian researchers are not well engaged with industry or with other parties. One indicator of concern is the low level of Australia firm collaboration on innovation activities with the higher education sector and public research institutions (see Figure 1.6).

Most OECD countries appear to rely on this OECD data to gauge the success of measures to encourage engagement and collaboration. The Australian performance in this OECD chart is based on data provided by the Australian Bureau of Statistics (ABS). Even if, for some inexplicable reason, the level of collaboration has been underestimated by as much as a factor of three, Australia would still fall at the bottom of the OECD list. The issue cannot be explained by a failure of measurement.

Furthermore, a recent ranking of the world's 100 most innovative universities by Thompson Reuters (based largely on patent-related data, but also including publications and citations with industry) did not include a single Australian university (Thompson Reuters, 2015).

The above data suggest that Australia should be seeking to achieve a larger dividend from its significant investment in public sector research and that current measures to encourage the engagement of public sector researchers with business and industry are not adequate.

To identify possible measures that Australia could adopt to improve the translation of publicly funded research, this report examines policies and programs in fourteen countries. When considering measures for application in Australia, this report takes into account the rationale of the measures, including their history and evolution,

outcomes and impact. The report acknowledges the country-specific innovation systems that these measures are a part of, and what they aim to achieve.

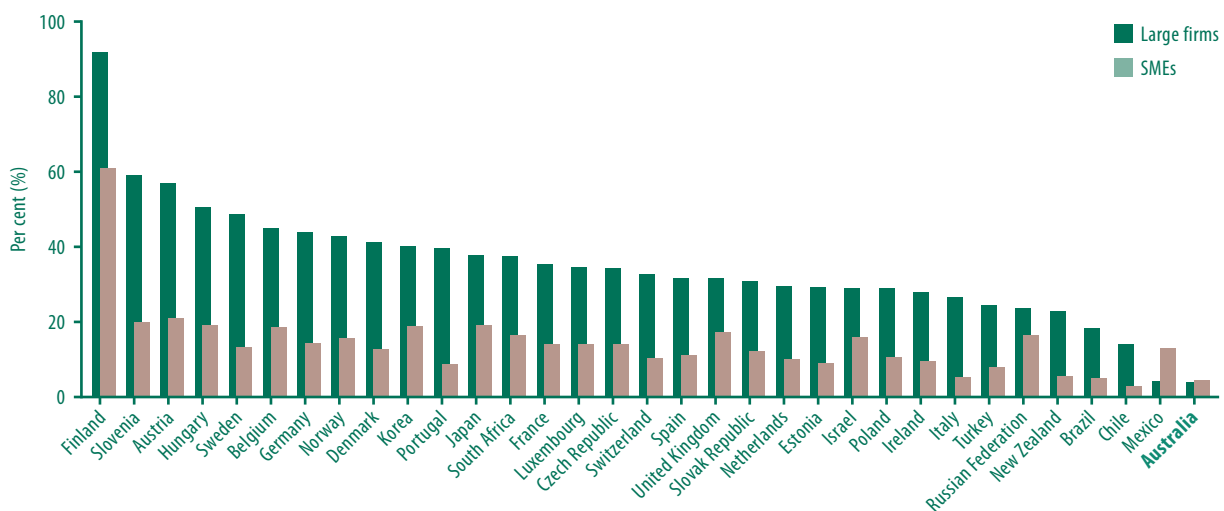
The report also discusses barriers to knowledge translation, such as the lack of incentives for public sector researchers to collaborate with firms, including career progression issues, limited funding for SMEs to become involved in collaboration, limited venture capital to grow start-ups, low levels of technically-skilled employees in firms to interact with public sector researchers, and intellectual property (IP) management issues.

1.3 Reasons to encourage the translation of research

Scholarly inquiry and organised research has been a key feature of modern societies for hundreds of years. The knowledge produced progressively generates a better understanding of our world, of ourselves and of the possibilities we may be able to pursue.

Australia's investment in public sector research generates benefits for Australia in a number of ways. For example, research undertaken in Australia's universities helps to ensure that students graduate with up-to-date skills that

Figure 1.6: Innovative firms collaborating with higher education/public research institutions



Note: As a percentage of product and/or process innovative firms in each size category. For Australia, data refer to financial year 2010/11 and include product, process, marketing and organisational innovative firms (including ongoing or abandoned innovation activities). Source: OECD (2013b), DOI: <http://dx.doi.org/10.1787/sti_scoreboard-2013-graph110-en>.

can be applied to benefit the economy and society. In addition, research outcomes provide Australians with new products and processes, and underpin the efficiency and competitiveness of our industry. More broadly, university research helps to identify and address pressing social and economic problems in areas such as healthcare, energy and the environment.

Haskel & Wallis have demonstrated strong economic benefits from publicly funded research in the UK. They “document a robust correlation between public-sector financed R&D disbursed via research councils and later market sector total factor productivity (TFP) growth” (Haskel and Wallis, 2013). Elnasri and Fox (2014) have used a similar methodology with Australian data to confirm the relationships found by Haskel and Wallis for Australia. This work shows that public sector knowledge capital is a source of positive spill-overs to private sector productivity in Australia. Increased collaboration between the public research sector and external parties can therefore be expected to provide economic benefits. For a more detailed analysis of the benefits of research to the Australian economy, see the report of *Securing Australia's Future*, Project 4 (Bell *et al.*, 2014).

With the emergence of an increasingly knowledge-based global economy, access to and application of relevant knowledge increasingly drives innovation leading to new products, services and business models. A key feature of the knowledge economy is that it is not the strength of the specific nodes (i.e. institutions) that is the central determinant of effectiveness, but rather the strengths of the connections between the nodes. This report examines measures which can enhance such connections.

It has long been recognised that the diffusion of knowledge and application is just as important as its creation (OECD, 1996). And while translation of research from the public sector through engagement with external parties has overall benefits to society, both the public and private entities concerned can reap significant benefits.

Publicly funded research institutes (PFRIs) and universities employ and educate highly skilled

individuals who have the capacity to deliver innovative technologies, services and knowledge to address national and global challenges. However to best achieve this, knowledge developed within universities and PFRIs needs to be translated and disseminated.

Recognising the importance of this flow of knowledge to application, many countries have invested in developing ‘supportive infrastructures’ which facilitate potential users in influencing researchers about what kind of knowledge they need, and researchers in finding someone who can see the potential of applying their idea.

1.4 The role of government in national innovation systems

Governments have a critical role in adopting policies that can support and drive innovation in changing national and international economic situations, and to reflect emerging challenges and priorities. Their role in ensuring public investment in science and research, and encouraging and supporting innovation within the private sector is important (OECD, 2007).

In addition to funding research, the fourteen countries reviewed offer a mixture of policies and programs to encourage and enhance the application of research into favourable outcomes. These include funding for start-ups, university based incubators and technology parks, intermediaries, management and licensing of intellectual property and training/mentoring for university student and faculty entrepreneurs. Furthermore, measures can provide assistance to researchers for collaboration, assistance to businesses (including SMEs), exchange and placement of researchers, technology transfer support and intellectual property support. All of these, in their various ways, can reduce the barriers to, and assist the translation of research findings.

The countries reviewed have each adopted a suite of measures to encourage the translation of public sector research. These measures target researchers, companies, and/or other parties to

address factors that impact on translation. While commercialisation is one desired outcome of translating research funded by public money, this is not necessarily the most effective mechanism to extract economic value. For example, the diffusion of a spatial map and supporting software system developed by CSIRO has substantially increased crop yields for a large number of farms through extension programs rather than direct commercialisation (for example by licensing to an agriculture supply company).

Spill-over and adoption benefits are significant. They cannot be captured by universities or public research institutes. As a result, in the absence of appropriate government policies and programs, universities and research institutes are likely to under invest in the translation of their research.

Thus one aim of government policies is to ensure the public sector research has impact—defined as “demonstrable contribution that research makes to the economy, society, culture, national security, public policy or services, health, the environment, or quality of life, beyond contributions to academia” (Department of Industry and Science, 2015). This has important implications for measuring the impact of research. Even IP licenses, commonly used to indicate the intensity of a university’s commercialisation activity, have to be assessed in the context of the ranking of patenting and licensing by both industry and researchers as among the least important channels to achieve research translation (OECD, 2013a).

The commercial transfer of knowledge and technology into the private sector is only one pathway to impact of research. In the UK, for example, income from the sale of intellectual property accounts for less than 5 per cent of universities’ externally earned income (Haskel *et al.*, 2014). Also important in this conceptualisation is the role of intermediaries, which can include university research partnerships offices and policy and business advisory bodies (Howells, 2006).

To help frame the particular issues examined in this report, the following conceptual framework is proposed.

1.5 A conceptual framework for considering research translation

Improved performance in research translation and business-researcher collaboration in Australia is of concern to government, business and the research sector. Government is increasingly emphasising the importance of demonstrating the impact of research as part of public sector expenditure accountability. Improved research translation and business-researcher collaboration benefits businesses through the access to ideas and knowledge, equipment and talent that they would not otherwise possess and which gives them commercial advantage.

The benefits to universities lie in not only new sources of income but also in active involvement of their researchers in the complex, interesting, and valuable problems that businesses face. These problems present new research opportunities and potential translation benefits. Extensive research in the UK shows that the researchers who are the most externally engaged with industry also win more grants and publish more (Hughes and Kitson, 2015; Perkmann *et al.*, 2015). In other words, researchers do not necessarily have to choose between engaging in research or building links with users—the two activities are complementary with each contributing to the performance of the other. But for many academics in Australia, the significance of their ERA scores is not viewed in that way.

Lifting performance requires an understanding of the complex and dynamic ways research is translated and businesses and researchers collaborate. There is a myriad of pathways by which ideas that emerge in the research sector are applied in the business sector. Reciprocal, iterative models of engagement have long replaced assumptions about the one-way linearity of any connections i.e. ‘science push’. Furthermore, establishing the connection between research and particular business outcomes is not straightforward. It becomes

increasingly difficult over time to attribute a business success to the results of research, rather than other contributing factors, such as marketing prowess. But this is not unique to a research-based input. Companies struggle to identify which part of their advertising budgets works, and how well.

Connections are built by a variety of different means, including the exchange of:

- Knowledge: e.g. scientific publishing, presentations at conferences, consulting, provision of training, data sharing;
- Technology: e.g. equipment, patents, standard setting, and
- People: e.g. educated, knowledgeable and skilled students and staff. The development of talented people is the largest direct impact that universities have on businesses.

Research institutions engage externally by using a variety of different modes of connection. They:

Convene and provide public space for

discussion: Universities have traditionally played a role in stimulating debates, hosting conferences and providing public lectures. Their staff curate knowledge in libraries and collections. Staff provide impartial, trusted advice and universities provide space to bring different parties together to discuss ideas and policies, sharing knowledge about problems and their solutions. The Internet and social media have extended such facilitative activities significantly, widening the opportunity for engagement.

Commercialise intellectual property: The traditional technology transfer approach employed by universities is used as a means to exploit research outcomes when ideas are thought to be of potential value. Intellectual property disclosures are protected and return is sought through licensing, starting businesses and their sale, to exploit ideas.

Participate in 'grand challenges': Many research projects aim to tackle complex, global challenges, often with participation of research users from



business, government or third-sector institutions, with the objective of creating new research domains and knowledge that will be shared in the public domain. This mode is becoming common with the growth of multi-disciplinary research institutes targeting seemingly intractable challenges in areas of global health, energy, climate, environment and data sciences.

Collaborate in strategic partnerships: The collaboration mechanism involves longer-term closely coupled interaction between universities and external partners, working together on programs that further the body of academic knowledge with outcomes that benefit both business and universities. They involve deep exploration of issues where the company creates rich and long-lasting relationships with university partners that, in turn, commonly offer the business rights of first refusal to license collaboration results. Partnerships often extend beyond research to include joint curriculum development and internships and recruitment.

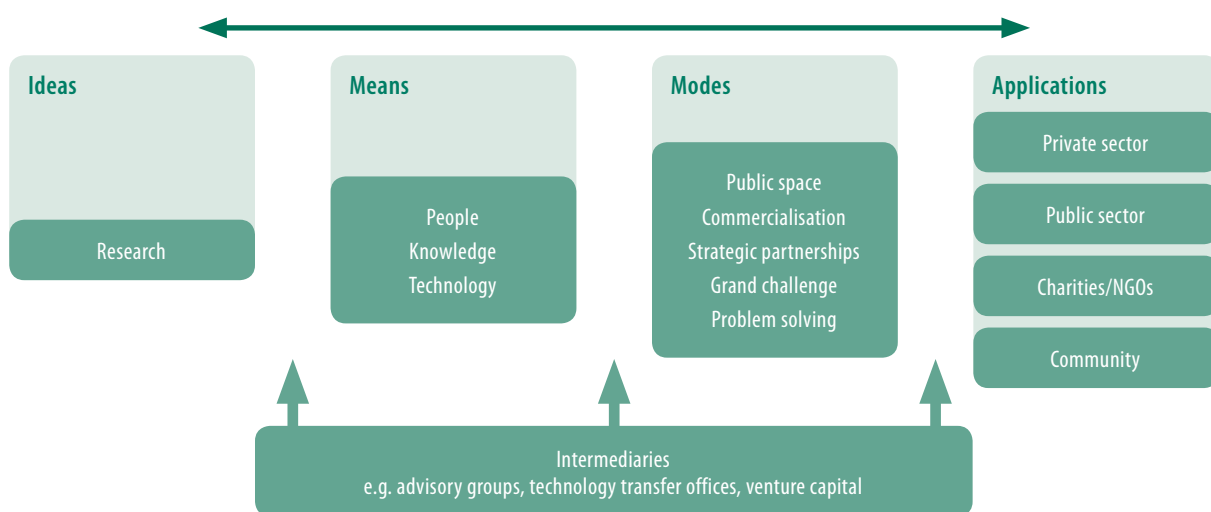
Problem solve: where researchers engage in providing solutions to technological, economic and social problems, through the provision of

consultancy and advice. These are often shorter-term forms of engagement but can lead to collaboration and research translation.

This system of research translation and business-researcher collaboration is captured in Figure 1.7. It is to be emphasised that it is a dynamic system in which the exchange of ideas occurs through interactions and flows of knowledge technology and people in ways that emerge and evolve over time. As a system every element is connected with all the others. Research that improves the wellbeing of the community or improves public policy making will, for example, also benefit business.

As Figure 1.7 shows, public sector research translation occurs in a multiplicity of pathways, involving a range of external parties, and has diverse purposes and outcomes. The country cases presented in this report provide only a sample of the different types of connections. Research translation involves the transfer of knowledge and technology. The measures discussed in this report provide incentives for many of these pathways.

Figure 1.7: Research translation and business-researcher interaction



Source: Dodgson (2015, personal communication).

There has been extensive research on government policies directed towards issues of commercialisation, intellectual property protection, venture capital and SMEs. This project has sought to draw on lessons from what is known about the various measures being used to encourage research translation and consider their place in the broader context of research translation. Key amongst these are lessons about long-term perspectives, continuity but adaptability in objectives, connectivity between the various parties involved, and appropriate levels of financial and other support. The objective of many of these initiatives is on changing behaviour and culture: i.e. by encouraging a particular collaboration, researchers and partners become generally better at interacting with each other.

1.6 Structure of this report

The EWG has undertaken a review of existing literature. The EWG has also had strong international inputs, including those from innovation experts who have been commissioned to undertake country reports. The report also draws on discussions and other inputs from key stakeholders in Australia.

This report provides a framework for reconsidering Australia's efforts at translating its investment of public funds towards research into economic, social and other benefits.

Chapter 2 discusses a range of different types of measures used in other countries and the rationale behind them.

Chapter 3 draws on the previous chapter to propose the sorts of measures that Australia should consider. It also identifies the key findings from the project and discusses key issues for Australia regarding its ability to translate research outcomes and suggests ways to overcome these issues drawing on international best-practice.

2

Measures adopted by other countries

Summary

This Chapter presents an analysis of selected research translation measures in the countries that have been reviewed. The measures were selected because they target key players in the translation of public sector research or because they address factors relevant to this issue. Measures relating to each of the targets or issues are described below.

2.1 Types of measures used to promote translation of research

As noted in Chapter 1, consultant reports describing research translation measures in fourteen countries, and Australia, were commissioned for this project. Details on these reports can be found in the Evidence Gathering section at the back of this report.

The information in this Chapter is largely derived from the commissioned reports. It has been supplemented by a literature



search. The authors of the commissioned reports were asked to focus on five measures that could include both programs and policies. The measures target the different parties that can be involved in research translation. The main focus of the consultant reports has been on measures taken by governments, with some examples from sub-central government. Some measures taken by public sector research institutions, including groups of universities, have also been identified. Appendix A summarises all the measures examined, by country. What is immediately evident is that most countries have adopted a range of different types of measures to address the translation of public sector research.

Nature of translation measures

Many of the measures described in this report involve financial incentives. Translation measures funded by government include the exchange or placement of public sector researchers or students with external parties. They also include tax measures to encourage public sector research translation.

Funding arrangements that require external parties to contribute are common. However, as the examples presented in this Chapter show, the generosity and scale of government funding to encourage research translation is significant.

What is also evident is the long-lived nature of many of these measures. Even where support programs for research translation have undergone significant change, they have generally continued to maintain core objectives, branding and administrative arrangements. This has provided certainty for researchers, the organisations for which they work and for their external counterparts. It has also contributed to the long term success of these measures.

In some cases, governments have enacted legislation to facilitate the flow of research outcomes to the private sector. The best known examples of this are the US Bayh Dole Act and the Stevenson Wydler Act. Under the US Bayh-Dole Act (the Patent and Trademark Law Amendments Act) of 1980, university recipients of federal research funds can own inventions arising from that research. Before the Bayh-Dole Act, federal research funding contracts and grants obligated inventors in both the public and private sectors to assign inventions from federally funding research to the US government. The Stevenson Wydler Act encouraged US federal government laboratories to engage in technology transfer. More information about this legislation can be found in Appendix B.

Other countries have passed laws to create frameworks and define the expectations of legislators in relation to what is expected from universities in return for government funding of research. Examples include Brazil, Denmark and Japan.

Targets of translation measures

Measures to encourage the translation of research are generally targeted at public sector researchers, or joint researcher-business partnerships with the latter being predominant. Some measures are targeted at technology transfer bodies, while others support intermediaries (which facilitate researcher-linkages with external parties). In addition, intellectual property arrangements have received attention.

Table 2.1 lists a selection of measures which are presented in Boxes in the subsequent analysis. These measures have been chosen from the larger number listed in Appendix A because they

are considered to be relevant and adaptable to Australia. The majority of these measures have been favourably reviewed. Many have operated for a long time. Some have been chosen because of their novelty. Others demonstrate leading practice in terms of their design and administration.

Additional details about these measures can be found in the country reports and other references. They cover a spectrum of the different approaches that are being used to encourage research translation.

2.2 Measures targeting business

Some research translation measures are targeted at business, particularly at small and medium sized enterprises (SMEs), and some at public sector researchers. Incentives to business are needed to overcome industry reluctance to look to public sector researchers for ideas and assistance, and considerable uncertainty about how to do this, and ‘which door to knock on’ at public sector research institutions. Thus measures that target business help to address an information failure.

The German ZIM Program is one measure that targets businesses. Additional examples operate in Brazil, Denmark, Finland, Israel, Japan, Singapore and the USA (Botelho and Alves, 2015; Johnston, 2015a; Johnston, 2015b; Shahaf, 2015; Toshihiko, 2015; Chu, 2015; Roessner, 2015). See Appendix A and consultant reports for further details.

2.2.1 Germany’s ZIM Program

Germany’s ZIM program (Box 2.1) supports companies, or groups of companies to collaborate with each other and/or with research institutes. ZIM is the most important support program for innovative firms in Germany. While it targets SMEs using a German definition, the size of firms supported can be large in Australian terms (the Australian Tax Office defines an SME as a firm with revenue of less than \$A20 million while ZIM is available to companies with annual revenues up to \$A69 million).

Table 2.1: Selected research translation measures, by country

Country	Measure	Target & Box
Brazil	First Innovation Program (<i>PRIME</i>). Support for pre-incubation and incubation phases. Competitive milestone-based grants to SMEs and grants to incubators.	Start-ups (Box 2.21)
Canada	Natural Science and Engineering Research Council (NSERC) <i>Engage</i> Grants to encourage business (especially SME) interaction with public sector researchers.	Strong focus on SMEs (Box 2.2)
Canada	Natural Sciences and Engineering Research Council (NSERC) <i>Idea to Innovation</i> (I2I)	Commercialisation of inventions (Box 2.7)
Canada	Canada's Social Sciences and Humanities Research Council support for students and recent graduates	HASS students and graduates (Box 2.9)
Chile	Strengthening Technology Licencing Offices in order to increase R&D commercialisation by supporting the improvement of policies, procedures, IP regulations and information systems.	University Technology Transfer Offices (Box 2.18)
Denmark	Vouchers for business development and R&D collaboration projects	SMEs (Box 2.4)
Denmark	National Network for Technology Transfer with membership including research institutions and business. Information sharing, courses, seminars and conferences to raise awareness of technology transfer processes	Universities and business (Box 2.14)
Finland	Finnish Agency for Innovations (Tekes) funding (loan plus grant) for young innovative companies to accelerate growth	SMEs with proven business concept (Box 2.3)
Finland	Tekes support for research projects that need further development in preparation for commercialisation	Researchers (Box 2.6)
Germany	SIGNO supports the protection of ideas from universities, business and inventors, to overcome information and financial barriers in relation to IP use and raise awareness of IP in commercialising innovation.	Universities, business and inventors (Box 2.19)
Germany	ZIM is Germany's major innovation measure directed at firms, groups of firms and collaboration between firms and research institutes	Business and research institutes (Box 2.1)
Germany	<i>Leading Edge Clusters</i> have been established in 15 technology areas. They have a regional focus and involve universities, the Fraunhofer Institutes and business.	Universities, government laboratories & business (Box 2.15)
Israel	<i>Kamin</i> supports applications-oriented research by progressing basic research that has potential for take-up by Israeli industry into an applied research phase.	Universities, business and start-ups (Box 2.10)
Israel	<i>MAGNETON</i> encourages technology transfer from research institutions to business through collaboration by funding joint projects.	Research institutions and business (Box 2.13)
Japan	Adaptable and Seamless Technology Transfer Program (<i>A-STEP</i>) supports industry-university R&D collaboration to develop commercial outcomes. Support is provided for phases ranging from feasibility studies to full scale R&D and possibly a start-up.	Universities and business (Box 2.12)
Singapore	The <i>Early Stage Venture Fund</i> (ESVF) provides funds to venture capital firms on a 1:1 matching basis to provide investment for Singapore-based early-stage technology start-ups.	Venture capital (Box 2.24)
United Kingdom	The <i>Higher Education Innovation Fund</i> (HEIF) provides 'third stream' funding to support university engagement with external parties.	Universities (Box 2.16)
United Kingdom	The <i>SETsquared Partnership</i> , between a group of UK universities, is funded through HEIF and Innovate UK to accelerate the growth of early stage high-technology ventures from both within and outside the universities.	Universities (Box 2.17)
United Kingdom	The <i>Catapult Program</i> supports nine Catapult Centres—sector-focused intermediaries that span the gap between universities and business.	Intermediaries (Box 2.22)
United Kingdom	<i>Knowledge Transfer Partnerships</i> (KTPs) place graduates in firms for two-year knowledge-transfer projects.	Students and recent graduates (Box 2.8)
United States of America	The <i>Small Business Technology Transfer</i> (STTR) Program operates in a similar way to the better known SBIR Program. Funded by a budget set-aside, it supports SMEs to collaborate with universities and other not-for-profit research institutes.	SMEs and universities (Box 2.5)
United States of America	Cooperative Research and Development Agreements (CRADAs) facilitate collaboration between government laboratories and business, which gets to own the IP and is required to manufacture any resulting product in the USA.	Government laboratories and business (Box 2.11)
Several countries	Easy Access IP—an approach to commercialisation being used by some universities where the IP is made available free in return for some commitments to engage with the university involved.	Universities and business (Box 2.20)

Box 2.1: Germany's ZIM

ZIM is Germany's Central Innovation Program for SMEs, introduced in 2008 following the merging of previous programs. It is designed to foster market-driven technology-based R&D work within German SMEs. It aims to enhance companies' capacity to innovate and to strengthen their long-term competitiveness. Companies with up to 250 staff, a turnover of up to €50 million (approximately \$A80 million) and a balance sheet value of up to €43 million (approximately \$A69 million) are eligible to apply. ZIM encourages cooperation between companies and research institutes through the formation of networks to achieve a direct transfer of expertise, leading to translation of new technological findings into marketable products, processes, and services.

Under ZIM, companies and the research institutes they work with can be awarded grants for ambitious R&D projects. Funding is not restricted to any particular field of technology or to specific fields of application. Success in obtaining a grant is dependent on how innovative the R&D project is and how marketable the results are likely to be.

The ZIM Program comprises three schemes:

- ZIM-SOLO funds individual companies doing their own in-house R&D work. Funding is provided for project costs and may also be provided for support and consulting on innovation including management consulting, technical support, technology transfer, training, database access and certification (total budget of €147m (approximately \$A236 million) in 2012).
- ZIM-KOOP projects funds R&D work carried out jointly by two or more companies or by one company and one or more research institutes. Funding may be provided for R&D cooperation projects between companies, or between companies and research institutes. All partners have to make innovative contributions (total budget of €325m (approximately \$A508 million) in 2012).
- ZIM-KOOP networks—funds external network management of innovative networks that comprise at least six SMEs which jointly develop a common innovation. Funding covers management services, individual and cooperation projects initiated by the network (total budget of €20m in 2012). Funding for networks typically occurs in two phases. Phase 1 includes development of network design, contracts and technology. Phase 2 includes network supervision, projects conducted by network partners, consulting and preparation for market launch.

In summary, projects must:

- seek to develop a new product, process or new technical services
- reflect the international state of the art in technology
- carry a significant, but predictable technical risk
- permanently raise company competitiveness in new markets and create or safeguard jobs
- cannot be realised without Program support, or only with a considerable time delay.

Project costs eligible to receive support in all projects include:

- personnel costs
- costs for project-related contracts to third parties (up to 25 per cent of personnel costs or 25 per cent of the total costs in the case of network management)
- other costs (lump-sum based on personnel costs: up to 100 per cent for companies and up to 75 per cent for research institutes).

The co-financing requirements are:

- R&D projects for companies: 35–55 per cent of the costs eligible for support, up to a maximum of €350,000 (approximately \$A562,000) per sub-project
- For research institutes: 90–100 per cent of the costs eligible for support, maximum support per ZIM-KOOP project: €175,000 (for cooperation projects: €350,000)
- For cooperation R&D projects: the costs eligible for support for the whole project are limited to €2 million (approximately \$A3.2 million)
- For network management, the central funding is progressively reduced, from 90 per cent in the first year, to 70 per cent in the second, 50 per cent in the third and 30 per cent in the optional fourth year. The maximum support for network management is €350,000, with no more than €150,000 in Phase 1.

Applications for a grant are approved for about 4,500 R&D projects annually. Proposals can be submitted at any time to the Program management agencies responsible for each element of ZIM. Final funding decisions are made by the Ministry of Economics and Energy (BMWi). Two reviews have both found ZIM to be effective (Fraunhofer ISI and GIB, 2010; IWH, 2011).

Small and medium sized enterprises (SMEs) are often the target for government measures to promote research translation. There are several reasons for this. SMEs are seen as needing more help than larger firms because they are often time-poor and lack the knowledge of where to go to find translatable public sector research. While larger firms may have staff assigned to liaise with universities and also have recent recruits with useful university contacts, this is generally not the case for SMEs. Thus there are market failure arguments that are specific to SMEs and justify these companies getting special attention.

This report provides details on measures that target SMEs in Canada, Finland, Denmark and the USA. Additional examples operate in Brazil, Germany, Israel, Singapore and the UK (see Appendix A and consultant reports for further details).

2.2.2 Canada's Engage Grants

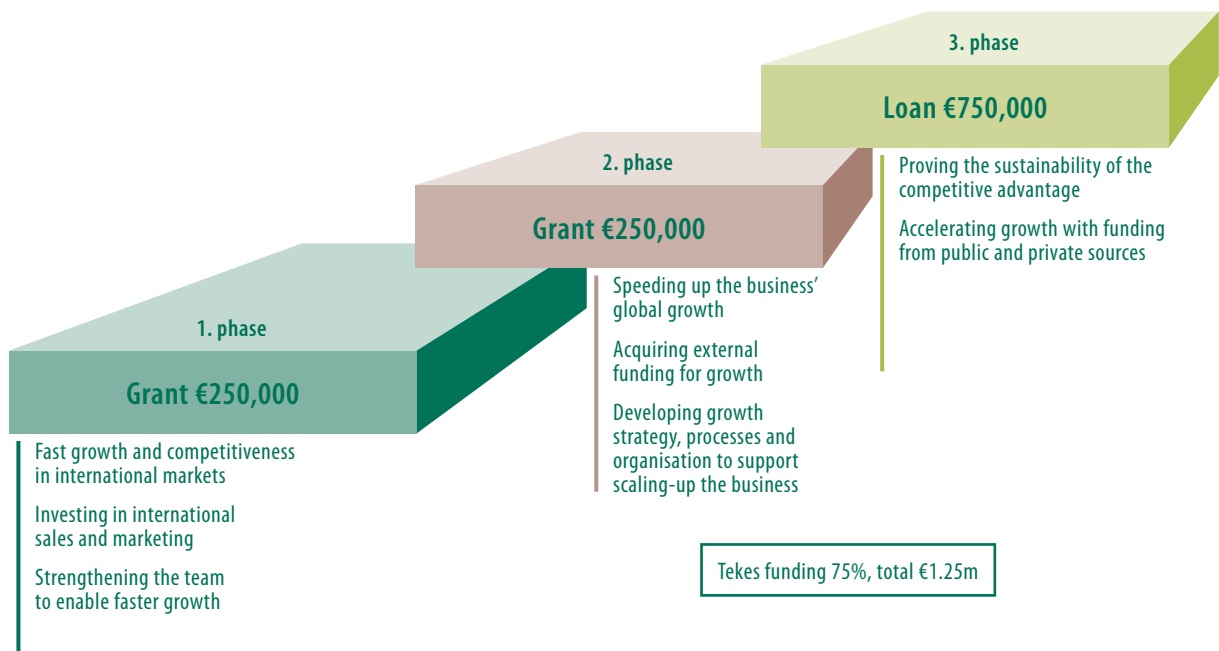
Canada's Natural Sciences and Engineering Research Council (NSERC) provides Engage

Grants (Box 2.2) which are targeted at assisting SMEs. NSERC's Engage Grants are designed to solve a company-specific problem. They also are intended to provide a foundation for larger follow-on collaboration between business and university researchers. These Grants focus on university-SME collaboration. Although they are subject to a number of restrictions, they have been well-received by the business community (Smith and van Dieen, 2015).

2.2.3 Finland's funding for young innovative companies

Finland's Funding Agency for Innovation, Tekes, offers a support program for start-up companies. This Program provides support, through three phases, for SMEs that can demonstrate that they have a proven business concept (see Box 2.3). The Program aim is to substantially accelerate the global growth of Finland's most promising small companies.

Figure 2.1: Structure of Tekes' funding for young innovative companies program, Finland



Source: Tekes (2015b).

Box 2.2: Canada's NSERC's Engage Grants

Engage Grants are designed to give companies that operate from a Canadian base access to the knowledge, expertise and capabilities available at Canadian universities and colleges. These grants are intended to support short-term R&D projects. A simplified application and decision processes enables researchers to quickly undertake new research collaborations that extend academic expertise to company problems. Engage Grants up to \$C25,000 (approximately \$A26,000) for a period of up to six months support well-defined research projects undertaken by eligible researchers and their industrial partners.

Applications for Engage Grants must provide evidence that they will create a strong partnership between the participants as well as detailed planning and sound budget justification. They must also spell out the underlying assumptions, intended approaches, milestones and deliverables. The project plan must detail regular interactions between the participants. In order to ensure that these grants deliver strong outcomes. Proposals are not eligible for an Engage Grant if they:

- focus on the commercialisation of a university or college invention
- focus on the routine application of existing technology or tools to the industry partner's operations
- provide routine analysis or routine use of equipment at the university or college
- collect data without interpreting underlying mechanisms
- seek to certify, endorse, validate or performance test an existing product, process or material (unless accompanied by significant efforts to improve or better understand the product, process or material)

- include activities aimed at excessive (more than two weeks) literature review and/or patent searches
- relate to the set-up and operational management of an institute or a formal or informal group of researchers
- provide professional practice or consulting services, or
- are principally associated with the acquisition and maintenance of scientific equipment.

Industry partners must operate from a Canadian base and demonstrate clear intentions and capacity to further develop and apply any technology within Canada. Start-up companies may be considered, provided that have a minimum of two full time employees or have been in operation for a minimum of two years.

Companies must demonstrate the ability to exploit the project's results, reflected by company resources, capabilities and experience. The company partner is expected to collaborate with the researchers at all stages of the research project including proposal development and, as the project unfolds, interact regularly with the research team. At minimum, an in-kind contribution from the company reflecting its active involvement in the project is required. Companies submit a four page application form and own any intellectual property arising from the project. Proposals can be submitted at any time and are evaluated within six weeks, with a 90 per cent success rate.

2.2.4 Denmark's Innovation Vouchers

Denmark provides Innovation Vouchers to SMEs (Box 2.4) to facilitate their access to public sector research. Vouchers schemes supporting innovation can be found in a number of countries but Denmark's vouchers are specifically targeted at research translation.

2.2.5 The United States' Small Business Technology Transfer Program

In the USA, the Small Business Technology Transfer (STTR) Program provides another

approach (see Box 2.5). This Program is a procurement-based initiative. The Small Business Technology Transfer Program (STTR) was closely modelled on the Small Business Innovation Research Program (SBIR), which had proved highly popular with the US Congress and with the small business community during the first decade of its 33 year life. The SBIR Program was discussed in a previous ACOLA report (Bell *et al.*, 2014). Both programs share similar basic goals, participation by many of the same agencies, use of a percentage of the external budget for funding, and a three-phased award structure.

Box 2.3: Finland's Tekes funding for young innovative companies

Tekes offers support for young innovative growth companies for comprehensive business development through the Young Innovative Companies Program. To be eligible these companies must have:

- the opportunity for fast growth in international markets,
- evidence of promising business activities and customer references,
- a clear plan to grow in international markets, and the capacity to implement the plan,
- a competitive edge with which it is possible to attain an important market position,
- a committed and competent management team, and
- the ability to attract venture capital.

Companies that meet these and other eligibility criteria can receive up to €1.25 million (approximately \$A2 million), of which up to €500,000 (approximately \$A800,000) may be funded as a grant and up to €700,000 (approximately \$A1.2 million) as a loan. Tekes funds 75 per cent of the eligible project costs, generally over three phases. Tekes and the company agree on goals which, when realised, enable the company to move to the next phase of funding. The total budget for the Program was just over €19 million in 2011.

The funding for the first phase is a €250,000 grant (approximately \$A400,000), typically for a period of 6–12 months. Companies that have progressed during the first phase in accordance with their targets get to present their company and their business idea to an evaluation panel convened by Tekes. These panels include investors, business angels and business professionals. They assess the company business potential, globalisation potential, development needs and suitability as an investment target. Companies for which this evaluation is positive move on to subsequent stages (see Figure 2.1).

The second phase of funding is another €250,000 grant. Loan-based funding of up to €750,000 can be granted, where a maximum of 30 per cent of the first loan instalment can be paid in advance. The loan has a low interest rate. Tekes do not take any equity ownership and the funding goes directly to the entrepreneur and other investors. If the recipient fails to achieve targets due to barriers to market entry, or if the innovative development work that the business is based upon proves to require more time than anticipated, the loan term may be extended to a maximum of ten years. The principal and interest of the loan may not be waived.

Eligible costs include some salary, machinery and equipment and services. Since 2008, 260 start-ups have been selected for the Program, and 75 have passed successfully through all three funding phases and attained 'Champion' status. Tekes continues to evaluate the impact of projects after their completion. Tekes and its programs were evaluated in 2012 (Tekes, 2015b; Technopolis, 2012).

Box 2.4: Denmark's Innovation Vouchers

Denmark's Innovation Voucher Program is primarily targeting SMEs, to assist them to raise their competence. It was introduced in 2008 by the Danish Council for Technology and Innovation to encourage SMEs to utilise the opportunities and potential of knowledge institutions. The measure aims at increasing the R&D and innovation capabilities of SMEs by fostering collaboration with public research institutions and research technology organisations, improving knowledge transfer and by strengthening quality and relevance of public R&D. Responsibility for the scheme now lies with the Innovation Fund Denmark, and since 2008, over 1,000 projects have been awarded grants.

The scheme is open to projects within all scientific fields and there are two different forms of vouchers:

- Basic vouchers are awarded for a research-based business development project. Government funding is 40 per cent of project costs, up to a maximum of €14,000 (approximately \$A22,000). The main focus is the successful transfer of knowledge to the SME.
- Extended vouchers are available for larger scale R&D collaboration projects. Government funding is 25 per cent, up to a maximum of €67,000 (approximately \$A108,000). The main focus of these vouchers is on finding new solutions to current problems. SMEs have to provide 50 per cent of the total funding, and the research institution at least 25 per cent. It is a prerequisite for the extended voucher projects that the participating knowledge institution itself carries out research on the field in question.

The following selection criteria are applied:

- the SME has to be a private enterprise
- the SME must have existed at least one year
- the project must not have received other public funding
- the company must be an SME with maximum of 250 employees
- the annual turnover of the SME should be less than €50 million (approximately \$A80 million)
- the SME should not have received public support over the last three years more than €0.13 million, and
- for the basic voucher the SME should not have spent more than €6,718 (approximately \$A10,800) on knowledge services over the previous three years.

There is one call for proposals every year. Funding is provided on a 'first come, first served' basis with no fixed deadlines for optimal flexibility. Research proposals must include an agreement between the research organisation and the SME, a project description, an agreement on the dissemination of research results and IP ownership, a budget and a declaration from the research institution.

A total of DKK 35 million (approximately \$A7.5 million) is allocated annually under this Program and is distributed by Innovation Fund Denmark.

Box 2.5: US Small Business Technology Transfer (STTR) Program

To be eligible for an STTR award, a small business must collaborate with a not-for-profit research institution such as a university, a federally funded R&D centre, or similar organisation. Although such collaborations take place under SBIR they are not mandatory for that Program. Both the SBIR and STTR Programs have been reauthorised several times.

The STTR Program has four goals: stimulate technological innovation, use small businesses to meet federal research and development needs, foster and encourage socially and economically disadvantaged persons' participation in technological innovation, and increase the private sector's commercialisation of innovations derived from federal R&D. The scale of this Program can be seen from the data in Table 2.2.

- Five agencies participate in the Program: the Departments of Defence, Energy, and Health and Human Services' National Institutes of Health; the National Aeronautics and Space Administration; and the National Science Foundation. From the 2016 financial year, each of these agencies with an external R&D budget greater than \$US1 billion (approximately \$A1.39 billion) is required to set aside no less than 0.45 per cent of its budget for the delivery of STTR awards. Agencies are responsible for organising and managing their own project solicitations, targeting research areas and setting priorities, and administration activities. In the Program's first year, 1994, agencies set aside around \$20 million to support collaborations and projects. The total annual allocation across agencies has grown considerably since then. The three phases of the program and the associated awards are as follows: Phase I awards are designed to assist SMEs to determine the scientific, technical, and commercial merit and feasibility of a proposed idea. Funding is limited to \$US150,000 (approximately \$A208,000) total costs for 1 year.
- Phase II awards grant up to \$US1 million (approximately \$A1.39 million) for 2 years. This phase is designed to assist with further develop the idea. Funding is normally awarded based on the results of Phase I and the scientific and technical merit and commercial potential of the Phase II proposal.
- The STTR Program does not fund Phase III. In some Federal agencies, Phase III may involve follow-on non-STTR funded R&D or production contracts for products, processes or services intended for use by the US Government. Phase III awards are to go to companies that developed the technologies in Phase I and Phase II and all grants are to be made on a competitive and merit-based basis. This phase is expected to result in commercialisation or further continuation of R&D.

Studies of the STTR Program undertaken by the US Government Accountability Office (Fraunhofer ISI and GIB, 2010; Ford *et al.*, 2008) have been positive. Ford and co-authors indicated that the Program provides a pathway to transition university technologies and knowledge to the private sector, creating a pipeline of future developments, collaborations and commercial success.

2.3 Measures targeting public sector researchers

While most research translation measures targeted at researchers are focused on those in universities, some are aimed at researchers in independent institutes and government laboratories. Small institutions are often not big enough to be able to employ commercialisation staff.

Measures that target public sector researchers that operate in Finland and Canada are explained below. Additional examples are operating in Finland, Germany, Israel and Japan (see Appendix A and consultant reports).

2.3.1 Finland's Creating Business from Research Ideas

Finland's Tekes offers assistance to public sector researchers to take promising research into the development phase (see Box 2.6). These research projects are intended to create new high-level competences in areas expected to be important for businesses in the future.

2.3.2 Canada's Idea to Innovation grants

Canada's Natural Science and Engineering Research Council (NSERC) Idea to Innovation (I2I) grants were launched in January 2011 (see Box 2.7).

Table 2.2: Average STTR awards, per annum, by type of institution 2001–12, USA

Total awards	\$US261,955,250
Funds to small business	\$US110,770,226
Funds to research institutions	\$US69,694,731
Number of awards to universities	692
Funds to universities	\$US67,370,241
Number of awards to FFRDCS	35
Funds to FFRDCS	\$US2,995,569
Number of awards to other not-for-profits	65
Funds to other not-for-profits	\$US7,053,059

Note: FFRDC—Federally funded research and development centres.

Source: STTR Annual Reports, 2001–2012 (SBIR, 2015).

Box 2.6: Finland's Tekes Creating Business from Research Ideas (TULI)

This Tekes program supports research projects where scientists develop an idea further in preparation for commercialisation. Eligible projects examine possible paths to market and the most promising route, and method, for taking the idea further. The possibilities of using the idea as the basis of a start-up, or developing it as a new business activity in an existing company are investigated. The research part of the project focuses on issues that play a key role in the commercialisation of the concept. Project can receive up to €350,000 (approximately \$A549,000) over 2–10 years.

In these projects, the preparation of commercialisation plays a significant role: at minimum it must account for 30 per cent of project costs in all phases. Expertise in preparing commercialisation may be outsourced. The applicant must have adequate rights to use the background IP and research results. The research organisation must be able to transfer the rights to the results to the party commercialising the idea after completion of the project.

The scale of the new business for which the preparation of commercialisation aims in the project must be significant. The application must contain an estimate of the scale of the business operations aimed for. The project must examine several alternative commercialisation possibilities. The project's direct aim may not be developing new business operations of a single company, either a start-up or an existing company.

The project must have adequate resources for preparing the commercialisation of an idea. The application must describe the competence and prior references of the persons responsible for the commercialisation. Where a start-up is an option, the application must describe the composition of the team behind the start-up. It must also describe how the commitment of the persons and competence needed in the start-up are to be ensured.

New knowledge and business from research projects usually are relatively short, approximately one year in duration. Eligible costs include:

- Examination of the research idea from the perspective of commercialisation
- Examinations of novelty determination of customer value surveys of competitors
- Examinations of intellectual property rights
- Experimental verification of the viability of an idea (Proof of Concept)
- Mapping of funding models
- Mapping of business models.

Two rounds of applications are considered each year. The Program is one of three funding instruments generated from the reformed system for allocating research funding that took place in 2012 (Tekes, 2015a). In 2012, Tekes provided a total of €28 million to around 100 projects, the majority of which were in the ICT and services sectors (VTT, 2013).

Box 2.7: Canada's Idea to Innovation Program

The Idea to Innovation (I2I) Program aims to accelerate the pre-competitive development of promising technology originating from universities and colleges by making it attractive to potential investors, and promote its transfer to a new or established Canadian company. Funding from the NSERC is provided to the University or college faculty members to carry out research and development. All proposals must include a technology transfer plan that describes how the work will proceed through the next stages in the validation process up to eventual market entry.

There are four funding phases that are characterised by the maturity of the technology or the involvement of an early-stage investment entity or industrial partner; Market Assessment, Phase I, Phase Ib, Phase IIa and Phase IIb. In all phases except the market assessment, the intellectual property must be protected, or protection should have been applied for

Market Assessment: The assessment should address a range of essential questions to ultimately demonstrate real market opportunities and demonstrate the approach, activities and tools to address the questions.

Phase I Reduction-to-Practice Stage: This stage is designed to advance promising technologies to attract early-stage investment and/or to build the intellectual in anticipation of transferring the technology to a new or established company.

Phase Ib: Funding can be made available for successfully completed Phase I projects with high promise to secure an investor or a licensing company.

Phase II Technology Enhancement: Projects are designed to provide scientific or engineering evidence establishing the technical feasibility and market definition of the technology, process or product. Projects require an early-stage investment entity (Phase IIa) or a company (Phase IIb) to share the costs of the project.

Table 2.3 summarises the application requirements. Applications for the program are accepted four times per year and subjected to peer-review by external reviewers and the I2I Selection Committee. The contribution is eligible for Canada's Scientific Research and Experimental Development tax incentive. The 2010–11 program budget was \$C5.7 million. The 2011 Review of Federal Support to Research and Development recommended that federal support for the I2I Program be expanded (Jenkins *et al.*, 2011).

Table 2.3: Summary of I2I application requirements by phase

	Market Assessment	Phase I	Phase Ib	Phase IIa	Phase IIb
Form 100 required	Principal applicant only	Principal applicant and co-applicants			
Duration (non-renewable)	Up to 12 months	Up to 12 months	Up to 6 months	6 to 18 months	Up to 24 months
Maximum amount requested from NSERC (% of project costs)	\$15,000 (75%)	\$125,000 (100%)	\$60,000 (100%)	\$125,000 (67%)	\$350,000 (50%)
Technology transfer activities: additional funds needed from ILO	\$5,000 (25%)	Half the cost supported by NSERC up to a maximum of 10% of the award. Institution or partner must cover the other half.			
Additional funds needed from partner (cost/risk sharing)	N/A	N/A	N/A	\$62,500 (33%)	50% of direct costs through in-kind and at least 40% cash

Source: NSERC (2015).

2.4 Measures targeting students and recent graduates

University students can play a key role in building the links that lead to the translation of university research into economic and social benefits. This is particularly the case where curricula requirements or placement schemes result in research students spending some time working in organisations that are external to the university in which they are enrolled. These students often become the channel through which knowledge and skills are passed. They can also act as an interface between their supervisor and the external party. One outcome that has been observed is that the supervisor becomes a consultant to the external party. Another outcome can be the development of significant follow-on research collaborations. For these reasons, placement arrangements are of interest.

2.4.1 The United Kingdom’s Knowledge Transfer Partnerships

One example from research undertaken for this project includes the UK’s Knowledge Transfer Partnerships (see Box 2.8). The KTP Program is distinguished by its emphasis on the need for university-business partnerships to be based on business need. It demonstrates the importance

of knowledge exchange through the transfer of individuals into a business environment, helping to embed a greater capacity for the business organisations involved to innovate in the future. As the Dowling report has noted, “people are central to successful collaborations” (Dowling, 2015).

A Canadian measure targeting students and recent graduates is discussed in the next section.

2.5 Measures which draw on the humanities, arts and social sciences

A number of the measures to encourage the translation of research described in this report are available to researchers in the humanities, arts and social sciences (HASS). These measures promote researcher engagement to contribute to social and cultural objectives.

2.5.1 Canada’s Social Sciences and Humanities Research Council support for students and recent graduates

Canada’s Social Sciences and Humanities Research Council (SSHRC) has a program which specifically targets HASS students and recent graduates (see Box 2.9)

Box 2.8: The UK's Knowledge Transfer Partnerships

Knowledge Transfer Partnerships (KTPs) aim to help businesses improve their productivity and competitiveness through better use of technology, knowledge and skills. Each KTP is a three-way partnership between a business, an academic institution and a graduate. The academic institution receives a grant to subsidise the cost of employing a recently-qualified graduate to work at the company. Typical KTPs last between 6 months and 3 years depending on the project and the needs of the business. However mini KTPs allows organisations with growth potential to address short term, tactical business issues over periods of 3 to 9 months (Innovate UK, 2009). The increased flexibility of mini KTPs is targeted at assisting SMEs and independent micro organisations that may not be able to commit to long term projects to access external expertise and reap the benefits that KTPs can provide. Some KTP opportunities are advertised online (Innovate UK, 2015a).

KTPs are delivered through Innovate-UK. The Program, then known as the Teaching Companies Scheme originated in 1975. Under this Program a graduate (known as an associate) works for a firm, usually for a two year period, on a specific knowledge-transfer project central to a firm's development. The technology that is subject to the knowledge transfer originates within a qualifying knowledge base partner, typically a university. A wide range of knowledge exchange activities are undertaken spanning management; marketing, business administration and policy; engineering technology; and IT, computer science and computation. Associates are jointly supervised by staff in the company and in the faculty at the university concerned.

The costs of the partnerships are part-funded by government and part by the participating business. In 2008–09 total expenditure under the Program was around £100 million (approximately \$A219 million), of

which £30 million was from the Technology Strategy Board (now Innovate UK), £11 million from other government sources and £63 million from business. The average annual SME contribution to a project is around £20,000 (approximately \$A44,000). In 2009 some 96 higher education institutions started new KTPs. Twenty institutions accounted for about half of the 977 active KTPs.

The Program has been the subject of a number of evaluations over its 35-year existence, providing substantial evidence that it is meeting its objectives. A review in 2002 showed that university partners were drawn from across the full range of higher education institutions (Segal Quince Wicksteed, 2002). A review in 2010 reported that 62 per cent of company partners subsequently offered the associate a permanent position and 82 per cent of associates accepted the offers. Academic partners are reported to produce on average two research papers for each project (Regeneris Consulting, 2010). A recent independent study evaluating the economic impacts of the KTP Associates and Knowledge Base, found that the return on public investment is £7.5–7.9 per £1 of KTP grant funding (WECD, 2015).

Between 2001–02 and 2007–08 the overall net additional impacts from KTP were:

- £4.2–4.6 billion (\$A7.8–8.5 billion) in new sales
- £1.6–1.8 billion (\$A3–3.3 billion) gross value added
- 5,530–6,090 jobs.

A recent review (Dowling, 2015) found that Knowledge Transfer Partnerships (KTPs) have proved to be highly valuable for facilitating knowledge transfer and seeding collaborations. While the number of KTPs funded has declined due to funding restrictions implemented in the 2010 comprehensive spending review (TSB, 2011), the Dowling review urged that the KTP Program funding be increased.

Canada is not alone in encouraging the engagement of HASS disciplines in the translation of research. The UK has long understood the opportunities for HASS to contribute to the innovation process (for example Bakhshi and Throsby, 2009){Bakhshi, 2009 #128}. The KTP scheme, described above, supports HASS engagement as also does HEIF (see Box 2.16). Brazil's PRIME Program (see Box 2.21) provides opportunities for HASS researchers to become involved in projects in health and social services.

Box 2.9: Canada's Social Sciences and Humanities Research Council support for students and recent graduates

Canada's Social Sciences and Humanities Research Council (SSHRC) also provides support for research, research training and knowledge mobilisation activities for students and recent graduates in the social sciences and humanities. The SSHRC is the federal agency responsible for supporting post-secondary research in the humanities and social science fields.

The SSHRC supports partnerships between academic staff and graduate students with private, public and not-for-profit organisations. SSHRC funding opportunities are available through three programs: Talent, Insight and Connection. In 2012–13, the SSHRC provided \$C337 million (approximately \$A356 million) in grants, fellowships and scholarships across 30 disciplines.

2.6 Measures which target both researchers and other parties

Most countries operate programs which bring together public sector researcher, industry and other partners. Some of these programs are similar to Australia's Cooperative Research Centres (CRC) Program and several are known to have been inspired by that Program. However in most cases the funding for the CRC Program's overseas counterparts is more generous.

Measures that target both business and researchers within Israel, The United States, Denmark and Japan are explained below. Additional examples operating in other countries can be found in Appendix A and within individual consultant reports.

2.6.1 Israel's Kamin Program

Of the various examples that have been reviewed for this project, several stand out. Israel's Kamin Program is summarised in Box 2.10. The Kamin Program bridges between basic research and applied research, the importance of which has not yet been recognised by business entities. The Program is supported from the Ministry of Trade and Industry and involves the Office of the Chief Scientist.

2.6.2 The United States' Cooperative Research and Development Agreements

US Cooperative Research and Development Agreements (CRADAs) provide a mechanism for collaboration between US government laboratories and firms (see Box 2.11). While there have been reports of difficulties in CRADA IP negotiations over the years, CRADA numbers are now used as an indicator of US federal laboratory engagement.

2.6.2 Japan's A-STEP

A-STEP is a comprehensive measure to facilitate collaboration and the translation of public sector research in Japan. A-STEP provides comprehensive support through various stages of innovation and product development (see Box 2.12).

Box 2.10: Israel's Kamin Program

The Kamin Program funds public sector research groups to continue a research project into an applied phase, where it is no longer eligible for support from competitive funds intended to promote basic research and where no Israeli firm is yet willing to co-fund the work. Applications are lodged by universities or their commercialisation companies. There appears to be two rounds of applications called each year. The principal investigator's salary cannot be paid from a Kamin grant, although it may be supplemented from another source. In 2011, the total funds available to the Office of the Chief Scientist were approximately NIS 1,963 million (approximately \$A702 million) (ERAWATCH, 2011). The funding available for individual projects is generous.

Proposals must:

- be technologically innovative,
- exhibit the potential to evolve into an industrial research program,
- show commercial and economic potential, and
- display the availability of supporting infrastructure at the university/institute and the commitment of the principal investigator (Yeda, 2015).

The Program aims to extract the potential of public sector research for the benefit of Israeli industry. Consultants are used to evaluate the business feasibility of the project (potential for take-up by business in Israel, competing products in the market, potential applications, economic feasibility, comparative advantage resulting from development of the technology etc.)

The Program allows for the transfer of the knowledge which will be created to companies (including to a start-up company) for further development of the technology and for developing products for the global market.

The grant rates are determined by the duration of the work:

- Research for up to 12 months, funded at a rate of 90 per cent to a maximum of NIS 360,000 (approximately \$A129,000)
- Research for up to 24 months, funded at a rate of 85 per cent to a maximum of NIS 680,000 (approximately \$A244,000)
- Research Extension Period (up to 12 months), funded at a rate of 66 per cent to a maximum of NIS 264,000 (approximately \$A95,000).

Companies are exempt from payment of royalties. However, they are required to keep the knowledge in Israel in accordance with Israel's R&D Law.

Box 2.11: US Cooperative Research and Development Agreements

During 1986 and 1989, important legislative changes in the US created Cooperative R&D Agreements (CRADAs) between Federal Laboratories and external parties, mainly industry. CRADAs are agreements between one or more federal laboratories and external partners to provide services, facilities, equipment, intellectual property, or other resources with or without reimbursement (but not funds). External partners provide funds, personnel, services, facilities, equipment, intellectual property, or other resources toward the conduct of specified R&D, consistent with laboratory missions. CRADAs have evolved in a number of ways over the years.

Partners can be business firms, universities, and not-for-profit organisations, but preference is given to small business and to firms that agree to manufacture any resulting products in the USA. The federal laboratories may grant, or grant in advance, licenses or assignments to inventions made by their employees during the course of the agreement. Partner organisations are

granted an exclusive license for a pre-negotiated field of use for inventions. Information developed under a CRADA is protected from public disclosure under the Freedom of Information Act.

The US has a large number of federal laboratories and they are under pressure to contribute to US Industrial competitiveness via technology transfer. The CRADA has become the most visible instrument in this area. Access to federal laboratory facilities is one aspect of CRADAs that is of particular importance to industry partners.

In 2012 there were 8,812 active CRADAs. By 2012 CRADAs accounted for just over 40 per cent of collaborative research relationships involving federal laboratories. Given the number of laboratories involved in CRADAs and the wide range of projects undertaken, it is difficult to quantify their value. Several US Government agencies have conducted studies of the impact of their technology transfer activities focusing on economic and employment benefits.

Box 2.12: Japan's A-STEP

The A-STEP (Adaptable and Seamless Technology transfer Program) managed by the Japan Science and Technology Agency supports collaborative industry–academia R&D based on the results of high-quality basic research (research output, IP, etc.) to ensure that the benefits of research are passed onto Japanese society. Depending on the R&D phase and objectives of each particular project, A-STEP determines the optimal R&D funding and R&D period to enable the pursuit of medium- to long-term R&D. Through this approach, the Program aims to bridge the gaps between academic research results and industry to realise highly effective and efficient innovation (JST, 2015).

A-STEP is a competitive program supporting collaborative industry–university R&D across feasibility and full-scale stages of R&D (illustrated in Figure 2.2). The number of projects approved by type and technology field is shown in Figure 2.3. Feasibility stage support is summarised in Table 2.4. Full-scale R&D stage support (see Table 2.4) includes R&D in preparation for the establishment of a university-launched start-up. A-STEP's budget in 2012–13 was ¥14.7 billion (approximately \$A174 million) and ¥8.1 billion (approximately \$A96 million) in 2014–15.

Table 2.4: Japan's A-STEP feasibility stage

Support type	Exploratory research	Seeds validation	Start-up validation
Support objective	Broad exploration of the potential for technology transfer of output from university research from a commercial perspective.	Academic research output is seen to hold potential technology 'seeds'. The applicants (academic researcher and a company) verify the potential for future practical application.	Verification of the potential for a start-up venture based on the output of academic research.
Applicant requirements	University or other research institute-based researcher.	Joint application by university or other research institute-based researcher and a company.	Joint application by university or other research institute-based researcher and an indirect support institution.
R&D period (in principle)	Single fiscal year	Up to one year	
Total R&D funding (including indirect expenses)	Standard amount: ¥1.3 m (approximately \$A15,000)	Standard amount: ¥8 m (approximately \$A93,000)	
Contract fund			

Source: JST (2015).

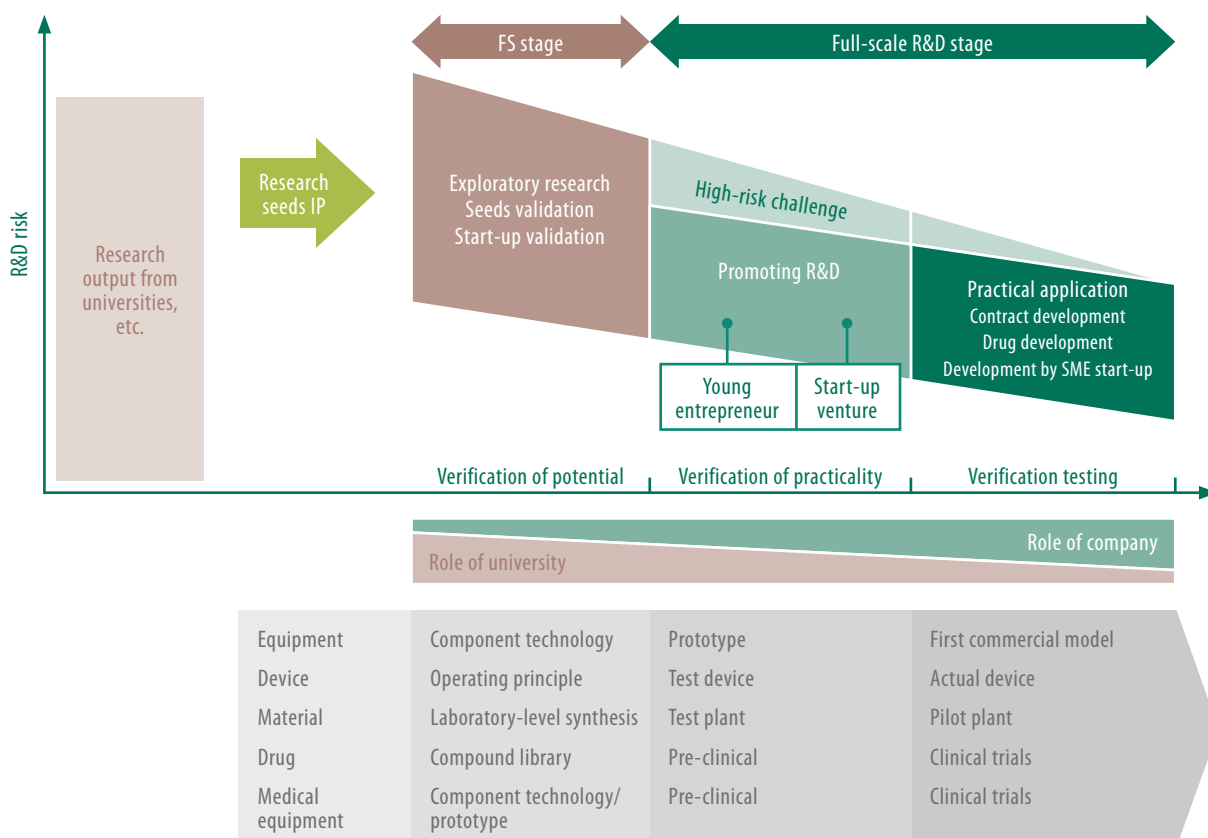
Table 2.5: Japan's A-STEP—full scale stage support

Support program type	Young entrepreneur	Start-up venture	High-risk challenge
Program sub-type			
Support objective	R&D support for young researchers who have a strong desire to start a business venture based on the application of their own research	R&D support for the establishment of a high-growth start-up venture based on technology seeds from academic research	Support for high-risk R&D projects. Covers R&D phase up to verification testing of technology seeds from academic research
Applicant requirements	Young researcher on a limited-period contract, and a venture start-up support organisation (e.g. university)	Three parties: Academic researcher, entrepreneur and indirect support institution	Company and academic researcher
R&D period (in principle)	Up to three years	Up to three years	Up to two years
Total R&D funding (including indirect expenses) (in principle)	Up to ¥45 m. Separately, up to ¥3 m as venture start-up support expenses	Up to ¥150 m Separately, up to ¥15 m as indirect support expenses	Up to ¥20 million
	Contract fund		

Note: ¥100 = \$A1.15 approximately.

Source: JST (2015).

Figure 2.2: The stages of innovation supported by Japan's A-STEP program



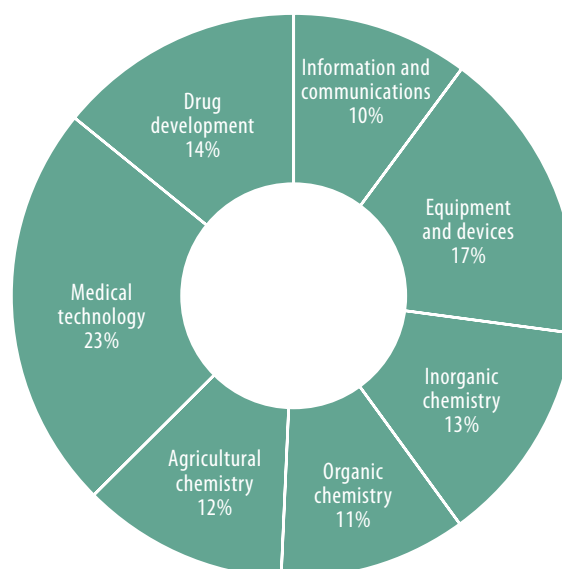
Source: JST (2015).

Promoting R&D	Practical application		
	Development by SME start-up	Drug development	Contract development
R&D support to establish core technology. Covers the verification phase for technology seeds from academic research	Support for development of technology seeds from academic research. Covers R&D-focused start-up ventures	Support for practical application development for novel drugs, etc., based on seeds from academic research	Support for large scale development of seeds from academic research. Covers projects that carry significant development risk
Company and academic researcher	Company (paid-up capital of ¥1,000 m or less) and academic researcher	Company (paid-up capital of ¥30,000 m or less) and academic researcher	Company and academic researcher
Up to four years	Up to five years	Up to five years	Up to seven years
Up to ¥200 m (matching fund)	Up to ¥300 m	Up to ¥1,000 m	¥100 m to ¥2,000 m
	Contract fund		Success: R&D funding repaid in equal instalments over 10 years Unsuccessful: repayment of 10%
	Payment of royalties based on product sales		

Figure 2.3: Japan's A-STEP, approved projects and technology fields

Number of projects approved by support type	
Feasibility stage	196
Seeds validation	171
Start-up validation	25
Full-scale R&D stage	86
Start-up venture	8
Promoting R&D	20
High-risk challenge	43
Practical application (Development by SME start-up)	13
Practical application (Drug development)	1
Practical application (Contract development)	1

Approved projects at the FS stage by technology field



Note: 2009 data.

Source: JST (2015)

2.6.4 Israel's Magnetron Program

Israel's Magnetron Program is an example of direct, generous support for research translation (see Box 2.13). Magnetron grants support collaborative research projects involving industry and universities. The project is managed by the industry partner, which receives the grant and pays the university research team. The Magnetron Program, administered by the Office of the Chief Scientist, aims to encourage technology transfer from research institutes to industry through research collaboration. Magnetron aims to maximise commercialisation of the technological capability in universities for the benefit of Israeli industry.

2.6.5 Denmark's National Network for Technology Transfer

Denmark's National Network for Technology Transfer has been established to help Danish research institutions meet their obligations to commercialise their research outcomes (see Box 2.14). Since January 2000, all employees at public Danish research institutions have been obliged to report inventions to their institution. If the institution decides to take over the rights to the invention, it must assist in the process

of commercialisation. The institutions are also responsible for ensuring that research results which have a certain probability of being used commercially are patented. The Danish Technology Transfer Act grants public research institutions the right to form and own a company and be a co-owner of one or more companies formed by other public research institutions.

2.6.6 Germany's Clusters

In recent years, Germany has focused its efforts on facilitating collaboration between academic institutions and industries by creating networks and clusters that include thousands of key stakeholders to strengthen Germany's position as a key centre of innovation (BMBF, 2015). The German Federal Ministry for Education and Research (BMBF) notes that the business world defines clusters as:

a conglomeration of companies, research facilities and other organisations which are linked by a common area of activity ... this physical and content related proximity creates trust ... Ideas are born, refined and jointly implemented. This gives rise not only to new partnerships and faster exchange of knowledge, but also to a competitive situation which creates a positive start-up climate.

BMBF (2015)

Germany's clusters are discussed in Box 2.15.

Box 2.13: Israel's Magnetron

Magnetron funding is provided for joint R&D projects. Part of the project is undertaken by the research institute and part by the industry partner. Upon project completion, the industry partner is expected to complete product development using the technology developed.

To qualify for Magnetron funding:

- the research institution must own the technological knowledge to be transferred
- there must be significant technological uncertainty that needs to be resolved before industry can make a decision on commencing a product development process
- the industry partner must have suitably qualified personnel
- there should be no business connections between the research group and the industrial corporation
- the technology must not already exist elsewhere and has not been developed by another company in Israel
- the industry partner must have the capability to realise the commercial potential of the product arising from the project.

Eligible projects receive grants of up to 66 per cent of the approved budget. The project duration is 12 to 24 months. The project budget can be up to NIS 3,400,000 (\$A1.2 million) for the two partner organisations. Companies cannot fund more than one third of their R&D through Magnetron. Project grant requests are submitted by the industry partner, who manages the project and pays the university research team from the grant. Industry partners are exempt from paying royalties on IP arising from the project. Funding allocated to this Program in 2011 was NIS 310 million (approximately \$A111 million) (ERAWATCH, 2012).

A 2009 evaluation of the Magnetron Program found that around 80 per cent of Magnetron Program projects involved a high level of innovation and achieved breakthroughs or new knowledge. Projects in communications, life sciences, optics and electronics had high success rates. Total annual funding for this Program is not known but is believed to be substantial.

Box 2.14: Denmark's National Network for Technology Transfer

Two Danish laws passed at the end of 1999: the *Act on inventions at public research institutions* and the *Act on Technology Transfer*, which act to motivate research institutions and their researchers to develop and commercialise their inventions. The Acts give institutions the right to take over the IP of their researchers in return for economic compensation and the opportunity to negotiate with industry (OECD, 2008). The *Act on inventions at public research institutions* led to the establishment of 5 patent consortia, and the collaboration of these formed the National Network for Technology Transfer in 2005.

The National Network for Technology Transfer manages *techtrans.dk*, an open forum for public research institutions, private business and others looking for information about the innovative collaboration between researchers and companies. The 16 members of the network are the technology transfer offices of the public research institutions. The aim of the network is to provide a national forum where public researchers and staff from companies involved in commercialisation can:

- Develop competencies
- Build knowledge and methods
- Share experiences
- Deal with intellectual property rights

In Denmark, the process to commercially exploit public research can involve setting up joint ventures and partnerships to share the risks and rewards of bringing new technologies to market. Other corporate vehicles, such as spin-out companies, are used where the host organisation is not in a position to develop a new technology. Raising capital is frequently part of the development process.

Through courses, seminars and conferences, the Network seeks to raise the collective awareness of and insight into the process of technology transfer—nationally and internationally.

Techtrans.dk operates the Patent Exchange, a data base of published patents and patent applications from public Danish research institutions. The Network members include six universities, several national research institutes and a hospital.

The Danish Agency for Science, Technology and Innovation co-fund the Network along with the member institutions, and they jointly coordinate an annual commercialisation survey. The National Network for Technology Transfer and to demonstrate the efforts and results of public research institutions in technology transfer.

The total revenues of public research institutions from commercialisation nearly doubled in its first year from 2005–06, and the survey shows that there has been a generally steady increase in the rate and value of commercialisation (Techtrans, 2015).

Box 2.15: Germany's Clusters

The German Federal Government has invested in the development of clusters that promote new technologies. These clusters are regional concentrations of public sector research institutions and industries. Clusters facilitate collaboration by linking firms, higher education and research institutions in a close geographical area. Public funding is provided to develop the networks and clusters and support research, but private investment is required to share the costs. Several high performance clusters were developed through the Leading-Edge Cluster Competition, and are an important part of Germany's High-Tech Strategy (BMBF, 2014b).

Leading-Edge Cluster Competition

Launched in 2007, the Leading-Edge Cluster Competition is a nationwide cluster funding program. In each of the three rounds of the Competition, five Leading-Edge Clusters were selected by an independent panel and awarded funding of up to €40 million each (approximately \$64 million) over a period of five years. The Program has received total funding of €1.2 billion (approximately \$1.9 billion) since 2007, with matching funding from the private sector and the BMBF. A further €500 million will be provided by BMBF before the end of 2017. Financial support is provided from the Federal Government for areas such as cluster management, innovation projects, educational activities and joint public relations initiatives.

Selection and funding of a Leading-Edge Cluster is based on the development of common strategic goals and the definition of future development projects in a particular area of technology. The involvement of the key players in the region's innovation and value-added chains is a major prerequisite. The following criteria are seen as pivotal in terms of strategy:

- Significant financial involvement of industry and private investors
- Planned projects build on strengths and lead to sustainable changes
- Increase in innovative capability and development of competitively relevant unique selling points to attain/consolidate a leading international position
- Measures to develop and try out innovative forms of co-operation, including professional cluster management
- Cluster-specific training, qualification and promotion of young talent

The program is open to all technologies and clusters are developed to utilise the strengths of each state. Several clusters have been developed that focus on the following topics: digitisation, production and communication; energy and resource efficiency; health; mobility and logistics.

The Fraunhofer Institutes are key players in the clusters. Currently the Fraunhofer maintains 66 institutes and research units, and had a budget of €2 billion in 2014. More than 70 per cent of the Fraunhofer research revenue is derived from contracts with industry and from publicly financed research projects, with less than 30 per cent contributed by the German Federal and Länder Governments. The Fraunhofer research orientation is largely demand driven. The institutes have a close relationship with both industry and universities and play a strong role in connecting academic and industrial research.

The Leading-Edge Clusters are helping to strengthen Germany's position as a key centre of innovation which enjoys a high international reputation. More than 2,000 stakeholders from science, business and society are implementing the strategies of the 15 Leading-Edge Clusters with great success in over 1,300 funded projects (BMBF, 2014a).

2.7 Measures targeting university administrations

In addition to providing incentives for individual researchers, some countries encourage their universities to take a more active role in encouraging engagement between their researchers and external parties, recognising that this can be expected to lead to greater translation of research outcomes.

2.7.1 The United Kingdom's Higher Education Innovation Fund

In the UK the Higher Education Innovation Fund (HEIF) has, for more than ten years, supported a range of university knowledge exchange activities (see Box 2.16). These activities often involve the translation of research results to parties external to the universities. HEIF accounts for only a small proportion of total UK Research Council funds. However, it is a sufficiently large amount of funding to influence the behaviour of the universities and their researchers.

The availability of HEIF and Innovate UK funding has resulted in some interesting initiatives. One of these, SETSquared Partnership, is described in Box 2.17.

2.8 Measures targeting technology transfer organisations

Most universities around the world have an office or a university-owned company that is responsible for technology transfer. In the past, these organisations focused on identifying IP that was considered worth protecting, usually by a patent, and then seeking to licence this IP to an existing company or, occasionally to form a new (start-up) company to commercialise the IP. However, some university technology transfer organisations (TTOs) in Europe and North America are now taking on a wider role of promoting engagement between university researcher and external partners.

There are suggestions in the literature that university TTOs have been part of the problem,

when it comes to engagement and to the translation of research. The literature suggests that TTOs can suffer from a number of problems:

- Lack of clarity on what constitutes success for internal and external stakeholders.
- Staff lacking necessary skills.
- Under-resourcing, and therefore unable to undertake or commission market analyses, finance the preparation of business plans, and IP strategies, etc.
- Interference by university management in issues that should be decided on commercial merits.
- Lack of commitment by university management.

This report provides details of measures that target TTOs in Chile. Additional measures operating in other countries can be found in Brazil, Canada, Denmark, Israel, Japan and Korea (see Appendix A and consultant reports).

2.8.1 Chile's Program to strengthen human capital for technology transfer

Chile has initiated measures to improve the performance of research commercialisation in its research institutes and universities (see Box 2.18).

2.9 Measures addressing Intellectual Property issues

University technology transfer organisations often have responsibility for identifying possible IP, deciding whether or not to protect it, and managing patent portfolios. These are challenging tasks which are subject to university policies. A provisional patent is relatively inexpensive. However professional drafting skills are needed. A provisional patent application does not need to state claims but should include a full description of the invention. A provisional patent application is not examined but it gives the applicant 12 months to decide whether to go further and seek standard patent protection. Technology transfer organisations often use

Box 2.16: The UK's Higher Education Innovation Fund

The Higher Education Innovation Fund (HEIF) Program is frequently referred to as 'third stream funding' because it is in addition to the two core elements of the UK dual funding structure for university research. The objective of the Program is to provide support for a broad range of knowledge-based interactions between universities and colleges and external parties (business, government and not-for-profit) which result in economic and social benefit to the UK.

A 2009 evaluation report (PACEC and The Centre for Business Research at the University of Cambridge, 2009) argued that specific funding for engagement should be an important part of a knowledge exchange system because it addresses system failures:

- Cultural inhibitions arising from traditional practices and norms of higher education institutions (HEIs) and their staff
- Under-investment by HEIs in their capacity and capability to engage in knowledge exchange
- Limited linkages between HEIs and other economic and societal agents
- Limited financial benefits to HEIs and their staff from engagement.

The HEIF Program has operated since 2002–03.

Allocations to universities are now made on a formula basis, reflecting the extent to which the universities demonstrate the most effective patterns of business engagement in their strategic HEIF bid for funds. The Program typically allocates between £110–150 million (approximately \$A235–320 million) per annum. The current engagement strategies of individual universities can be accessed via the HEFCE website (HEFCE, 2015).

A survey prior to the 2009 evaluation found that between 28 and 41 per cent of knowledge exchange income to the HEIs could be attributed to third stream funding. On the basis of 20 per cent additionality, an investment of £592 million through HEFCE third stream funding in the period 2001–07 has been estimated to generate £2.9 billion (approximately \$A6.3 billion) in gross additional knowledge exchange income. Thus, for every £1 of HEIF invested, the return is approximately £6 in gross additional knowledge exchange income. This ratio is higher for the more research intensive HEIs (PACEC, 2012).

Box 2.17: The SETsquared Partnership

The SETsquared Partnership involves universities of Bristol, Exeter and Southampton and partner universities of Bath and Surrey. Established in 2003 and funded by the Higher Education Innovation Fund (HEIF), the aim of the partnership is to accelerate the growth of innovation and technology businesses to stimulate economic growth in the regional economy through supporting early-stage, high-technology, high growth potential ventures from within and outside these universities. Based on the success of the original five Centres, a sixth cluster was established in 2014 in Basingstoke, to expand SETsquared's mission.

The Partnership has successfully supported more than 1,000 companies through access to industry specialists, investors and experienced entrepreneurs, and provides opportunities for industry to access academic ideas with commercial potential and develop collaborative research relationships. SETsquared has also helped these companies raise over £1 billion (approximately \$A2.2 billion) in investment. There are many collateral gains for Higher Education Institutions, SMEs and other parties outside the SETsquared alliance.

The collaborating universities are involved in and offer a range of joint initiatives and courses and provide access to shared resources. Placements of entrepreneur within a laboratory environment to work directly with the academics are also offered.

SETsquared Centres

Each university has its own SETsquared Centre of experienced staff who provides tailored support advice and mentorship to companies while they are in the start-up phase. The Centres offer support in a range of areas specific to the needs of each individual company and may include marketing, legal, intellectual property and financial advice. The Centres also offer flexible working space to provide access to resources and encourage collaboration.

Business review panels are established by the Centres to monitor how ventures are tracking and offer strategic advice with the review process occurring every four months. The review panels are made up of experienced business people and SETsquared staff.

The SETsquared partner universities, between them, received 8–10 per cent of the UK's higher education research budget.

Innovation to Commercialisation of University Research Program

In 2014–15, the SETsquared Partnership, the Higher Education Funding Council for England (HEFCE) and Innovate UK collaborated to run the pilot Program 'Innovation to Commercialisation of University Research Program'. Funding is provided for research projects undertaken at SETsquared and affiliated universities to determine whether there is a market for products or services that utilise their research and if there is evidence of market demand, licence the research or develop a spin-out company.

Up to £35,000 (approximately \$A77,000) can be provided to a team for a three month Market Validation stage and up to £15,000 (approximately \$A33,000) post the initial three months. Applications for the funding should be made by an early career researcher who also acts as the entrepreneurial lead, with the support of a senior researcher and a business adviser. At the end of the initial three months, teams present their business plan to an options panel that offers expert guidance on development pathways that will result in commercial success. Projects that possess strong market potential will have the opportunity to secure further grant funding for new company creation.

The £3.2 million (approximately \$A7 million) pilot was funded by contributions of £2.8 million (approximately \$A6.1 million) from the HEFCE and £400,000 (approximately \$A875,000) from Innovate UK.

this period to find a company that would like to license the patent. Several pathways are then available to complete the successful transfer of technology.

Measures addressing IP issues that operate in Germany and through a wider global network are explained below. Another IP-related measure operates in Brazil (see Appendix A and the relevant consultant report for more details).

Box 2.18: Chile's Program to strengthen human capital for technology transfer

Chile's Program to strengthen human capital for technology transfer aims to support technology licensing offices (TLOs) to achieve knowledge transfer and business creation from R&D outcomes in Chile's universities and technology centres. The Program also seeks to improve the opportunities for the TLOs, by increasing the number of researchers that work on applied research activities and technology development.

The Program was established in 2011 and is funded by Chile's innovation and entrepreneurship agency (Corfo) to address the need to create a group of specialists or technology managers who are qualified and capable of leading and training other skilled professionals. This includes increasing the presence of technology commercialisation specialists in universities, and supporting associations of these professionals to ensure the continuous development and to organise accreditation.

During 2011 the first stage supported 18 projects in 21 national universities and technology centres. As a result, these TLOs developed new policies, procedures and intellectual property regulations, information systems, and increased their networks. The second stage involved 15 institutions.

The measure aims to generate human capital capabilities in technology transfer and R&D commercialisation management. To reach this outcome, the grant recipient was required to hire a training institution with international standing and proven excellence to deliver the project. The training institution provides educational courses, or develops programs or training courses that enhance the technology transfer and R&D results commercialisation, delivering theoretical and practical training.

The annual cost for the Program is around \$A500,000. Corfo covers 80 per cent of the total project cost to a maximum of around \$A10,000 and the recipient must cover the remaining 20 per cent. Since 2011, the Program has supported over 200 people. Since the Program commenced, the number of patents being sought by Chilean universities has increased significantly.

2.9.1 Germany's SIGNO Program

Some countries have developed programs to improve the understanding of IP among researchers, to provide information on patented research available for commercialisation and to encourage the use of patents in protecting IP. One example is Germany's SIGNO Program (see Box 2.19).

Box 2.19: Germany's SIGNO Program

SIGNO, a Program of the federal Ministry of Economics and Technology, supports SMEs, universities and individual inventors in using IP rights to protect and commercially exploit their innovative ideas. The main objectives of SIGNO are overcoming information and financial barriers to use IP and to raise awareness about the relevance of IP for commercialising innovations. SIGNO comprises three sub-programs:

- SIGNO Universities facilitates the commercialisation of university IP to industry by assisting the process of making patent-protected scientific and technical information available to businesses that might take-up a licence.
- SIGNO Enterprises operates an SME Patent Initiative that offers grants up to €8,000 to SMEs that want to use IP rights for the first time.
- SIGNO Inventors provides inventors with key information on how to use IP rights. An inventors' competition targets young inventors, with awards are given to the most innovative and creative ideas.

The selection criteria for the SIGNO University Program are:

- Quality of the proposed project
- Originality and sustainability of the project's strategy
- Impact of the proposed projects towards the realisation of the overall aims of SIGNO
- Sustainability of the proposed activities
- Scope of influence
- Contribution to the conceptual enhancement of the utilisation of R&D results

There is a two-stage selection process for the strategy funding: pre-selection of projects on the basis of short proposals and a final selection on the basis of more detailed proposals. Project awards of up to €42,000 (approximately \$A67,000) are available. The budget for SIGNO in 2012 was €16.5m (approximately \$A26.4 million). SIGNO has supported 23 Patent Commercialisation Centres, which realised total revenue of about €22m (approximately \$A35 million) between 2002 and 2008.

An evaluation of SIGNO by Prognos AG and Boehmert & Boehmert in 2010 concluded that SIGNO support, differentiated by the target group, has been proven successful (Prognos AG and Boehmert & Boehmert, 2010).

2.9.2 Easy Access IP

Another approach that is receiving attention is Easy Access IP (see Box 2.20). University-developed technologies are often at an early stage of development and require significant investment and product development effort to generate commercial impact. Easy Access IP provides a mechanism which allows companies and individuals free access to these technologies so new products and services can be developed that will benefit society and the economy.

Box 2.20: Easy Access IP

Easy Access IP is an international group of universities and research institutions who believe in creating impact from research outcomes via knowledge exchange. Members of this group are drawn from eight countries and include the University of Glasgow, University of Copenhagen, Kings College (University of London) and the University of NSW.

Easy Access IP institutions have adopted four key principles:

- Universities exist to create and disseminate knowledge. This approach aims to maximise the rate of dissemination through knowledge exchange
- The aim is to create impact from university research outcomes as opposed to generating revenue
- Simple one-page agreements are used, making it easier for industry to work with the institutions
- An Easy Access IP agreement is viewed as the beginning of a collaborative relationship, not the end of a knowledge exchange process.

Easy Access IP licensees are asked to:

- demonstrate how they will create value for society and the economy,
- acknowledge the licensing institution as the originator of the intellectual property,
- report annually on the progress on the development of the Easy Access IP,
- agree that if the IP is not exploited within three years, the licence will be revoked, and
- agree that there will be no limitations on the licensees' use of the IP for the university's own research.

2.10 Measures targeting university start-up companies

University start-up companies have sometime been held to be the ideal outcome in relation to the translation of university research. This is a mistaken view. Start-ups often require a very significant commitment from the original researchers; university staff have other responsibilities. Start-ups also require commercial skills which university staff rarely possess. International experience suggests that successful university start-ups only occur in exceptional circumstances. When they do, there are issues that need to be addressed including, the appointment of Directors, raising capital and complying with company law.

Brazil had a program to assist the start-up firms and this is further discussed below and Germany operates the Start-ups from Science (EXIST) program that aims to improve the entrepreneurial environment at universities and research institutes and to increase the numbers of technology and knowledge based company start-ups.

2.10.1 Brazil's Program First Innovative Firm

Brazil has recognised the need to develop and promote an entrepreneurial culture to facilitate the growth of new businesses, create jobs and strengthen the economy. OECD analysis shows that from 2001–11, young firms (five years of age or less) generated about 50 per cent of all new jobs created, although accounted for just over 20 per cent of total non-financial business sector employment. During this time period Brazil was characterised by high employment growth and a surge in entrepreneurial activity. Brazil's measure to assist the formation and growth of start-up companies are described in Box 2.21.

Box 2.21: Brazil's Program First Innovative Firm (PRIME)

As part of support for pre-incubation and incubation phases for start-ups, Program First Innovative Firm (PRIME) was launched in 2009 with an objective to contribute to regional development, technological innovation and the rise of small innovative companies in Brazil. To achieve this, the Program aimed to help high value-added start-ups overcome financial difficulties in the critical early stage of their development.

Administered by FINEP (Brazil's Funding Authority for Studies and Project)—which is responsible for administering the main block funding for innovation, financing and risk financing in Brazil—the Program awards locally competitive milestone-based grants of up to €96,552 (R\$200,000) to start-ups to assist in the structuring of business plans and in the development of new products and services by small business. Successful awardees had to be operational for up to two years, have a high level of innovation in their products or services, a business plan that suggests growth potential, and defined challenges and goals that could be met within two years. The total budget for the Program was approximately \$A374 million over 2009–12.

To implement the PRIME Program nationally, FINEP sought regional partners, or anchor incubators, who had proven credibility and capacity to provide support to innovative ventures. Initially, there were 17 anchor incubators in operation around Brazil.

Between 2009 and the end of 2010, the Program had provided funding to 1381 start-ups. However it did not meet the expected target of 1895 for this period. In 2011 the Program was redesigned and FINEP announced the launch of a second edition of PRIME in partnership with the micro and small enterprise support institution (SEBRAE) (Botelho, 2011). One of the main changes for PRIME was that, to obtain financial resources, companies have to find matching resources. It focused on priority areas: information technology, biotechnology, energy, health, social development, and defence. The Program has not been operating since 2012.

PRIME has brought benefits to the community such as an increase in the number of jobs, revenue growth of some firms and larger financial capital, however the generation of new products and patents was limited (de Aragão Gomes *et al.*, 2013).

2.11 Measures targeting innovation intermediaries

Innovation intermediaries are specialist organisations that act as brokers, bridgers, information providers and translation facilitators. See Howells (2006) for a detailed discussion of the role on innovation intermediaries). The UK's Catapult Centres (Box 2.22) and Scotland's Interface Program (Box 2.23) provide examples of the use of intermediaries.

2.11.1 The United Kingdom's Catapult Centres

The UK's Catapult Centres combine features of Australia's NCRIS, CRC and Industry Growth Centre Programs. Catapults are relatively new, so it may be too early to form a judgement of their effectiveness. However, their focus and scale make them a measure of interest for this report.

2.11.2 Scotland's Interface Program

Since 2005, Interface has been providing Scottish SMEs with central point of access to the expertise available in Scotland's Higher Education and Research Institutions across a range of sectors. Their core mission is "to enable business-academic collaborations for economic and societal benefit".

Box 2.22: The UK's Catapult Centres

Launched in the UK in 2010–11, the Catapult Program was developed with the specific purpose of creating a new category of intermediate organisation acting as an interface between the business and university sectors. Two 2010 reports (Hauser, 2010; Dyson, 2010) made the argument that the UK required long-term investment in a network of technology and innovation centres based on global best-practice. The vision for the centres was that they would be required to provide business with access to the best technical expertise, infrastructure, skills and equipment. Regarding the technology readiness level index, the Centres were designed to be located across the Technology Readiness Levels 3 to 7 (R&D has been demonstrated in a laboratory environment through to prototype demonstration in operational development), where it is argued that there is a major gap in the UK innovation system.

Since the launch, the Catapult Program has evolved through a series of stages, each of which has involved the creation of a new Catapult Centre. The Catapult Centres bring together the UK's businesses, scientists and engineers to work side by side on late-stage research and development—transforming high potential ideas into new products and services to generate economic growth.

There are currently nine Catapult Centres. These Centres are as follows:

- Cell therapy
- Digital
- Energy systems
- Future cities
- High value manufacturing
- Off-shore renewable energy
- Precision medicine
- Satellite applications
- Transport systems

The funding model for a Catapult Centre is that one third of the funding of a Centre's activities should be from the public sector, one third should be from the private sector and one third should be from the university sector. The overall budget for the Program was around £120 million in 2012-13 (approximately \$A262 million, which implies an average funding of around \$A29 million for each centre that year). The Hauser Review of 2014 recommended that this funding model should continue, and there should be an expansion of the Program, with a budget close to £1 billion per annum (approximately \$A2.2 billion) and 20 Centres by 2020 (Hauser, 2014). Combined with private investment and competitive R&D funding, the total commitment to the Catapult centres in their first five years will be nearly £1.5 billion (de Silva and Andersen, 2015). The first Centre—the High Value Manufacturing Catapult—was launched in 2011.

The evidence demonstrates that Catapult Centres have been able to develop a critical mass of investment to ensure that they can act as an intermediary organisation, spanning the gap between universities and potential applications. The number of international businesses involved with the different Centres indicates that they are already contributing to UK economic growth. Innovate UK regularly monitors KPIs from each centre to assess intermediate measures of success such as inputs and activities, to assess early outputs and to measure KPIs against baselines in the long term.

Catapults are positioned in areas that will best address the identified needs of Catapult partners. For example, the Future Cities Catapult is located near London Bridge, an area that is significantly under developed and where there are opportunities to work with developers and authorities in the area.

Box 2.23: Scotland's Interface Program —The knowledge connection for business

Interface is an independent and impartial broker that was originally created by the Scottish Universities with funding support from the public sector. Interface now has a long established track record of translating the needs of industry and facilitating business—academic partnerships. Within ten years, Interface has introduced over 2000 businesses to academic partners. Seventy eight per cent of enquiries presented to Scottish research institutions are from SMEs (Interface, 2014; BiGGAR Economics, 2013).

Interface operates with a regionally based team that assists external parties to access the research and problem solving capabilities contained within Scottish Higher Education Institutions. They help translate business needs into proposals for consideration by academics, to facilitate the formation of partnerships between business and academia. Interface also provides support and guidance to these partnerships. The following services are provided free of charge to clients by Interface:

- Translation and brokerage services to match business requirements with academic expertise.
- Facilitation of collaborative projects between businesses and researchers through knowledge sharing and co-creation of solutions to support the development and commercialisation of new products and processes.
- Establishing multi-party collaborative projects where groups of businesses and academics look to solve industry wide challenges.
- Access to cutting edge and cost effective facilities and existing technologies.
- Advice on innovation related funding streams—most notably managing the various Innovation Voucher Schemes which provides business with up to £5,000 for their first academic partnership.

Interface administers a number of funding schemes to offset the cost of collaborating with Scotland's universities, research institutions and further education colleges enabling them to develop new products and processes through R&D projects. These include Standard Innovation Vouchers (up to £5,000), Student Placement Innovation Vouchers (up to £5,000), Follow On Innovation Vouchers (up to £20,000), Horizon 2020 SME Engagement Scheme (up to £5,000), Interface Food & Drink Funding (up to £25,000), and additional funding streams.

Recently Interface has worked in partnership with trade bodies and other support organisations to facilitate groups of businesses to work together collaboratively on a common issue. These are called Common Interest Groups. Interface also works new and emerging Innovation Centres (Interface, 2015).

Interface is funded by the Scottish Funding Council, Scottish Enterprise, Highlands & Islands Enterprise, The Scottish Government, and the European Regional Development Fund. The initial annual budget was around £200,000. The program's annual budget is currently around £1 million (approximately \$A2.16 million).

2.12 Measures addressing capital needs of start-ups

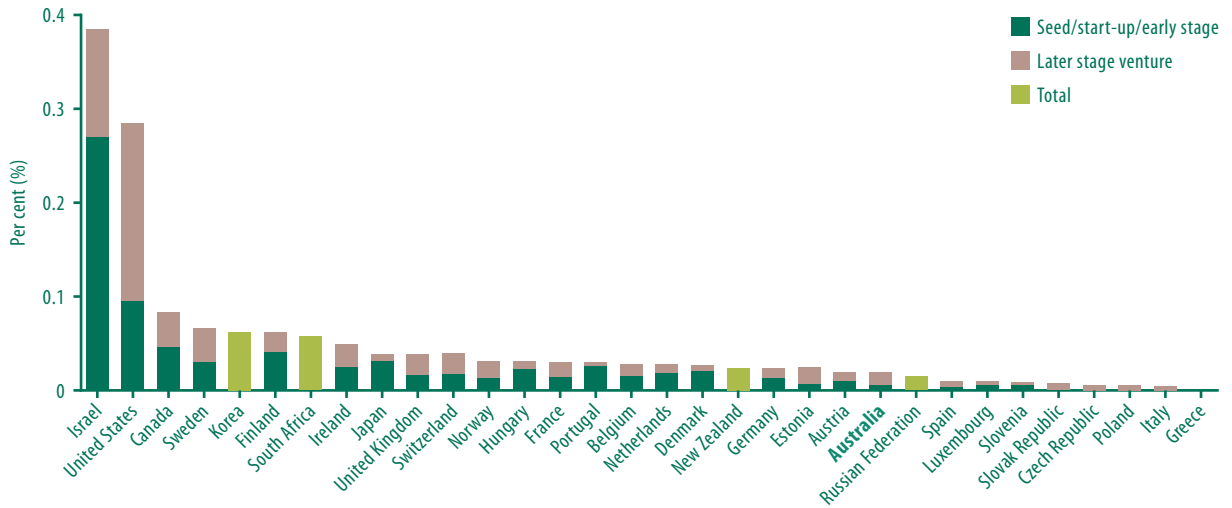
Capital investment is an essential element of support for start-ups. While start-ups represent a small proportion of the outcomes of research translation, they receive a lot of attention in the measures described in this Chapter.

Loans are also an important source of finance for start-ups. These are increasingly combined with grants. The interest can be lower than bank rates but more often it is slightly higher than bank rates to reflect risk. Repayments may be deferred and, if the project is not successful, may be partially or wholly forgiven. Government guarantees, usually through a government financial institution, are common. Appendix C summarises loan arrangements in eleven countries.

Venture capital and angel investment are also important sources of capital. Some of the government measures described in this report are aimed at providing initial seed capital, recognising the difficulty of obtaining capital in the early stages of a start-up and the 'valley of death' problem where a start-up continues to burn capital before substantial cash flow from sales can be achieved. In the majority of countries for which data are available, venture capital investments represent a very small percentage of GDP, often less than 0.03 per cent. Exceptions are Israel and the United States, where the venture capital industry is more mature and represents close to 0.4 per cent and 0.3 per cent of GDP respectively (see Figure 2.4).

Most measures of this type are generally available (i.e. available to all SMEs regardless of whether translation of public sector research is involved). However some specifically target research translation. The Singapore Early Stage Venture Funds are relevant and appear to be successful (see Box 2.24).

Figure 2.4: Venture capital investments as a percentage of GDP



Source: OECD (2015b).

2.12.1 Singapore's Early Stage Venture Fund

The Early Stage Venture Fund (ESVF) is an initiative administered by The National Research Foundation (NRF) Singapore to finance venture capital funds in order to provide early stage investment for Singapore-based early-stage technology start-ups.

Box 2.24: Singapore's Early Stage Venture Fund

The NRF matches private sector investments up to \$S10 million with venture funds which are to be used to fund early-stage local high technology start-ups in Singapore. The NRF takes a corresponding equity stake in each of the funded companies. In order to incentivise investors, NRF will only take profits up to five per cent rate of return (based on simple interest), and any surplus profits can be distributed to the other investors depending on the amount of investment made. However in the event of a downside, the NRF funding, which capitalises the investees, offers a first-loss protection to reduce risk for fellow investors.

The venture capital firms have the option to buy out NRF's share of the fund within five years by returning NRF's capital with interest.

Until 2015, the scheme has enabled over 20 companies to be funded by the 11 participating venture capital firms, three of which have been acquired. The first round of funding took place in 2008, providing a total of \$S50 million to five venture funds. Since then, the original five funds have invested \$S38 million in 24 start-ups.

Evaluation of successful funds is carried out by an eight-member panel comprising public and private sector representatives appointed by the NRF.

3

Consideration of measures that could be adopted in Australia

Summary

This Chapter considers the contextual factors relevant to successful research translation. It discusses leading practice principles that should guide the design of measures to encourage the translation of public sector research. Based on these considerations, measures to target each of the parties involved in translation (researchers, business, universities, etc.) are discussed.

3.1 Contextual factors for research translation

There are a number of factors that determine the successful translation of public sector research for economic and social benefit. These are evident from the consultant reports commissioned for this project. They include:

- Culture—some countries such as the USA and Israel have a strong entrepreneurial culture. However, even in these countries, the governments provide incentives for translation.



- Availability of businesses interested in and capable of translating public sector research outcomes—Australia does not have large numbers of the types of businesses that are interested in taking research results through to application. Other countries with a broader industrial base are better positioned in this regard.
- Overall level of R&D activity—countries with a strong national R&D performance can provide a wide range of opportunities for research translation.
- Major differences in the extent of recruitment and ongoing employment of PhDs by industry.
- Level of interest in public sector research on the part of not-for-profits and government—some countries have a well-established practice of drawing on public sector research capabilities.
- Availability of a range of incentives to encourage research translation—the countries reviewed for this report offer multiple incentives to the different parties involved.
- Stability and continuity of support measures is the key to generating best outcomes and maintain researcher and business sector interest.

- Variations in the structure of the higher education sector with some countries having more private universities and others having a mix that includes technical universities.
- Minimising disincentives for research translation—the pressure on public sector researchers to focus on publishing the outcomes of their research in highly ranked journals needs to be offset by rewards and recognition of translation activities.
- Information issues—business often does not know where to go or who to approach in the public sector to get advice and find research partners. Innovation intermediaries can play an important role in overcoming information failures and linking SMEs with public sector (and vice versa).
- Availability of capital—countries in which capital is available to start-ups and growing SMEs tend to do better in the translation of public sector research.
- The balance and sharing of responsibilities in federal countries between central government and state government—several countries examined for this project have federal systems of government. The extent of involvement of sub central government in research translation varies widely. Some states in the USA and provinces in Canada are very active in this area and have been active for many years.

3.2 Leading practice measures for research translation

This section identifies a selection of leading practice translation measures that target the relevant parties and issues. These measures reflect the leading practice principles described earlier in this Chapter. In particular, measures to encourage research translation require clarity of purpose, continuity and significant levels of funding.

Finding 1.

Australia can improve the translation of public sector research for economic and social benefit by establishing a stable suite of well-funded and sustainable, leading-practice measures

While Australia's measures for encouraging the translation of public sector research have evolved over the last ten years, this has occurred in a piecemeal manner, involving a number of state and Commonwealth agencies offering measures, generally with very modest funding. As noted above, Australia's measures to support the translation of public sector research have been found to be inadequate. They are also often short term in nature. In many cases there has been inadequate reporting of program outputs and minimal evaluation of achievement.

This report provides a number of examples where stable, well-designed and funded measures in other countries have created jobs, increased business turnover and provided other benefits. The project has found that leading practice

Table 3.1 presents data and information that helps to understand the national context of the measures discussed in this report. This Table is provided to help the reader understand the national contexts of the translation measures described in this report. However apart from the USA and, to a lesser extent Germany, there appear to be few examples where measures are specific to the conditions in particular countries. For example, measures targeting both researchers and business are generally similar across all countries reviewed. Where there are differences, they are generally minor and can arise because of:

- The state of development of national innovation systems—for example some countries in South America have started to modernise their innovation systems relatively recently.
- The scale of government laboratories—the USA has a significant number of government laboratories and these provide a wide range of opportunities for research translation. Examples include space (NASA) and nuclear energy (Oak Ridge and Los Alamos).

measures from other countries can be used to develop a carefully targeted suite of incentives to encourage Australian researchers, universities and business and other parties to work together.

Many of the most effective measures discussed in this report have operated over many years, continuing to maintain core objectives, branding and administrative arrangements. This stability has provided certainty for researchers, public sector research organisations and external counterparts. This report provides a number of examples, including the United States' Small Business Innovation Research Program and the Canadian NSERC's Engage Grants, where stable, well-designed and funded translation incentives have created jobs, increased business turnover and provided societal benefits.

The effectiveness of incentives to encourage research translation described in this report has been demonstrated through evaluations and reviews. Incentives need to recognise the breadth of potential interactions between public sector researchers and other parties. They also need to accommodate the range of responsibilities and accountabilities within agencies at different levels of government.

3.2.1 Incentives for business including SMEs

As can be seen in Chapter 2, there is extensive support to encourage business to engage in research collaboration and translation. Every country reviewed provides direct financial assistance to business. There is a particular, but not exclusive, focus on SMEs. However the turnover and employee number limits in the eligibility criteria appear to be high by Australian standards. Those SMEs with strong growth prospects (identified in part through the eligibility criteria) receive particular attention.

Finding 2.

Supporting SMEs and start-ups with high growth potential will help to increase the translation of public sector research in Australia

Small and medium-sized enterprises (SMEs) are important receptors for the translation of public sector research. They are often able to take up and adapt new ideas quickly. SMEs with high growth potential are the target for many of the government measures reviewed for this project. They are an important source of future jobs and economic growth. However, compared with larger firms, SMEs are often time and resource poor. They also often do not know where to go to find help, or to seek research outcomes, from universities. There are market failure arguments that are specific to SMEs and justify these companies getting special attention. Programs such as Germany's ZIM Program and Brazil's First Innovation Program (PRIME) are examples of effective measures that target research translation at business.

Start-up and spin-out companies from public sector research institutions represent a small proportion of research translation. However, evidence shows that they are an important source of new business opportunities and jobs (Anyadike-Danes *et al.*, 2013). Countries as diverse as Canada and Finland both have well-established leading practice measures to assist such companies. Adopting some of these approaches in Australia will help ensure that we grow a new generation of technology-based firms to follow in the footsteps of Cochlear, Resmed, and CSL—all of which had public sector origins.

The argument for providing incentives to business to seek out translatable university research is that business will apply the disciplines of the market that it hopes to address. This commercial approach to research collaboration provides a 'reality check', which is considered important in separating out research outcomes with real commercial prospects from those where the outcomes are less certain or need much more development before they can be translated. Of course, what one company rejects as not feasible another may see as providing a worthwhile opportunity.

Table 3.1: Key Economic, Science and Technology Indicators for countries in this study

Country	GDP ^a		GDP by Sector ^b			Population ^c (2014)	GERD ^d (2013)	
	Billions, USD	Ratio of GDP to Australia's	Agriculture	Industry	Services	Thousands	% of GDP	OECD Ranking
			% of total GDP					
AUS	1063.0		3.7	28.9	67.4	23826.6	2.13	15
BRA	2973.9	2.80	5.8	23.8	70.4	199700	N/A	N/A
CAN	1565.8	1.47	1.7	28.2	70.1	35540.42	1.62	21
CHL	22.3	0.02	3.5	35.5	61.1	17836.23	0.39	34
CHN	16157.7	15.20	9.2	42.6	48.2	1360720	2.08	N/A
DNK	253.3	0.24	1.3	21.2	77.5	5643	3.06	6
FIN	218.4	0.21	2.7	27.0	70.3	5462.1	3.31	4
DEU	3704.9	3.49	0.9	30.8	68.4	82384	2.85	8
ISR	271.7	0.26	2.4	25.7	71.9	8211.9	4.21	1
JPN	4635.6	4.36	1.2	24.5	74.3	127053	3.47	3
KOR	1732.4	1.63	2.3	38.3	59.4	50423.7	4.15	2
SGP	307.9	0.29	0.0	25.0	75.0	5470	2.00	N/A
SWE	437.4	0.41	1.8	33.4	64.8	9696.1	3.30	5
UK	2530.5	2.38	0.6	20.6	78.8	64511	1.63	20
USA	17419.0	16.39	1.6	20.7	77.7	318796.2	2.73	10

Country	Researchers ^h	Public Sector Researchers ⁱ	Firms Collaborating with Researchers ^j		
	per 1000 employment	% of Total researchers	% of SMEs	% of Large firms	OECD Ranking
AUS	8.5	79.9	4.1	3.5	33
BRA	1.46	N/A	4.6	18.0	30
CAN	8.93	42.8	N/A	N/A	N/A
CHL	0.95	62.4	2.7	13.6	31
CHN	1.83	37.8	N/A	N/A	N/A
DNK	13.61	37.9	12.4	40.8	9
FIN	16.06	42.2	29.2	70.0	1
DEU	8.37	43.6	13.9	43.2	7
ISR	14.17	15.9	15.6	28.6	23
JPN	10.07	25.4	18.7	37.3	12
KOR	12.79	20.2	18.3	39.8	10
SGP	N/A	49.4	N/A	N/A	N/A
SWE	10.66	30.3	12.9	48.2	5
UK	7.95	62.3	16.8	31.3	19
USA	8.81	N/A	N/A	N/A	N/A

Notes and sources

AUS=Australia, BRA=Brazil, CAN=Canada, CHL=Chile, CHN=China, DNK=Denmark, FIN= Finland, DEU=Germany, ISR=Israel, JPN=Japan, KOR=Republic of Korea, SGP=Singapore, SWE=Sweden, UK=The United Kingdom, USA=The United States of America.

a Gross Domestic Product at current prices and PPPs, 2014 or latest available data(OECD, 2014a; Department of Statistics Singapore, 2015). **b** Composition of GDP by sector of origin, 2014 or latest available data (CIA, 2015). **c** National Population, 2014 or latest available data (OECD, 2015c; OECD, 2015e). **d** Gross Domestic Expenditure on R&D, 2013 or latest available data (OECD, 2015c). **e** Government Expenditure on R&D, 2013 or latest available data (OECD, 2015c). **f** Business Expenditure on R&D, 2013 or latest available data (OECD, 2015c). **g** Charges for the use of intellectual property (Balance of Payments, current US\$), 2014 or latest available data (The World Bank, 2015).

GOVERD ^e (2013)		BERD ^f (2013)		IP Trade ^g (2014)		
				Receipts (R)	Payments (P)	Balance (R-P)
% of GDP	OECD Ranking	% of GDP	OECD Ranking	Millions, USD		
0.24	14	1.23	14	813.1	3939.7	-3126.6
N/A	N/A	N/A	N/A	375.1	5922.7	-5547.6
0.15	24	0.82	23	4033.7	10213.3	-6179.6
0.02	33	0.14	34	86.4	1548.4	-1461.9
0.34	N/A	1.60	N/A	886.7	21033.1	-20146.4
0.07	32	2.00	8	2244.0	1538.7	705.3
0.30	7	2.28	4	3715.4	1833.8	1881.6
0.43	2	1.91	11	13797.1	8122.2	5674.9
0.09	29	3.49	1	1006.7	985.0	21.7
0.32	5	2.64	3	36825.1	20923.2	15901.9
0.45	1	3.26	2	5150.9	10368.6	-5217.7
0.20	N/A	1.22	N/A	3150.8	22230.2	-19079.4
0.12	26	2.28	5	7455.5	2722.2	4733.2
0.12	27	1.05	18	20002.9	10837.1	9165.8
0.30	6	1.92	10	132653.0	41940.0	90713.0

Innovative Firms ^k		HRST Occupations ^l			S&T Occupations in Total Employment ^m
		Professionals	Technicians & associate professionals	Total	
% of all firms	OECD Ranking	Percentage of total employment			Normalised performance index (OECD median=100)
40.7	5	21.4	14.7	36.1	123.2
31.51	N/A	6.7	7.7	14.4	8.4
44.7	2	N/A	N/A	29.9	95.3
8.92	30	N/A	N/A	N/A	52.8
N/A	N/A	N/A	N/A	5.8	-39.3
31.98	11	17.2	23.8	41.0	138.8
30.58	13	19.0	16.6	35.6	123.8
46.55	1	15.3	22.1	37.4	125.8
41.27	4	N/A	N/A	N/A	97.5
18.1	25	10.9	3.9	14.9	11.1
15.96	27	N/A	N/A	19.2	35.8
N/A	N/A	N/A	N/A	N/A	N/A
32.03	10	19.8	21.5	41.3	142.4
23.91	21	15.3	12.9	28.1	85.0
N/A	N/A	17.1	18.1	35.2	118.0

h Number of Researchers per thousand employment, 2013 or latest available data (OECD, 2014c). **i** Percentage of Total Researchers Working in the Higher Education or Government Sector, 2013 or latest available data (OECD, 2015c). **j** Firms collaborating on innovation with higher education or public research institutions, 2008–10 data (OECD, 2013b). **k** Product and/or Process and Marketing and/or Organisational innovators, 2010 data (OECD, 2014c). **l** Human Resources in Science and Technology Occupations, 2010 data (OECD, 2011). **m** Science & Technology Occupations in total employment, includes both professionals and technicians, 2010 or latest available data (OECD, 2015a).

All the countries reviewed provide support for business research *and development*. This support is provided through both direct and indirect (tax-based) measures. Australia is currently unique in the OECD in regard to the extent to which it relies on indirect measures. This approach has some advantages—it allows companies to make decisions on research activities as and when necessary, rather than having timing dictated by grant application cycles. However, indirect measures tend to be untargeted. As a result, it is difficult to be confident that they provide better value for money than direct support. Australia is overly reliant on indirect measures (Figure 3.1).

Direct measures to incentivise business collaboration with public sector researchers are always subject to eligibility criteria to ensure that those most likely to generate beneficial outcomes receive support. In addition to turnover and employee limits, eligibility criteria often include limits on the total amount of assistance a firm can receive in any one year. As a result, direct measures can and usually are much more targeted than indirect measures.

Finding 3.
Australia can make greater use of direct support measures for business innovation to increase research translation

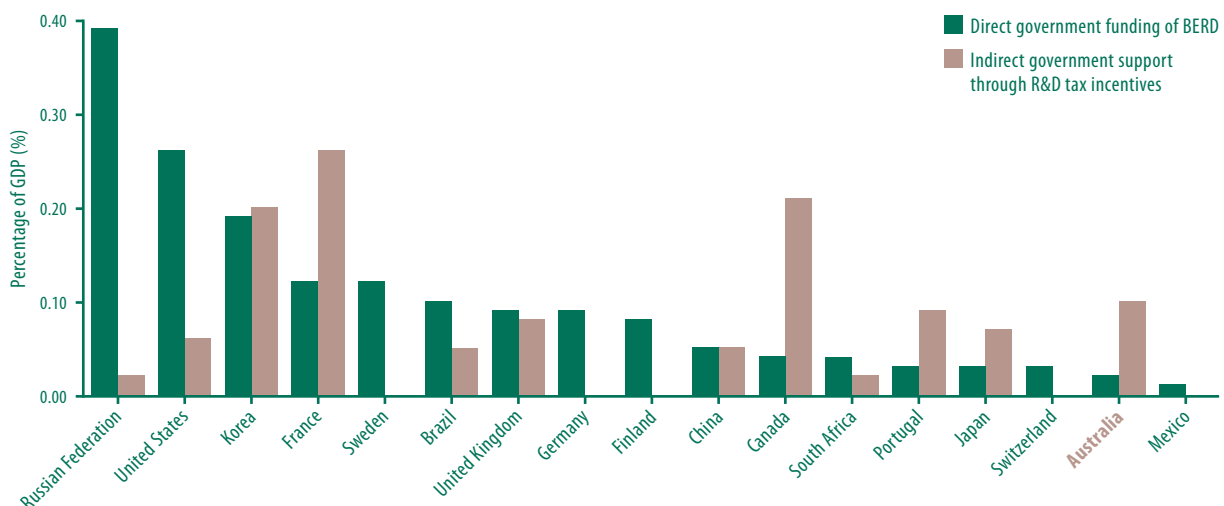
Firms that undertake R&D are more likely to become involved in the translation of public sector research. The project has found that

Australia is overly reliant on indirect support for business R&D through the R&D tax incentive. Shifting the balance of government support for business innovation to greater use of direct measures such as grants, loans and procurement contracts would allow a more focused and targeted approach to support for research collaboration and translation.

Loans, which in other countries are increasingly combined with grants, are becoming a significant source of finance for start-ups and SMEs with high growth potential. Australia can learn from other countries in this regard. International examples of loan schemes include The Zero Interest Rate Program (JURO ZERO) in Brazil, Korea's Industrial Technology Development Loan Fund and Germany's ERP Innovation Program.

While most countries offer indirect incentives to enhance and promote R&D activity, such as R&D tax incentives, several countries studied by this project offer a specific or additional R&D tax incentive to promote collaboration. To be eligible for this benefit, companies must collaborate with or contract research to universities or other publicly funded research institution. Examples of countries where these translation-focused incentives are provided include Japan (for collaboration), the UK (for contracted research), Denmark (for collaboration), Quebec (for contracted research) and Chile (for contracted research).

Figure 3.1: Direct government investment in business R&D, and tax incentives for R&D 2011



Source: adapted from OECD (2013b), DOI: <http://dx.doi.org/10.1787/sti_scoreboard-2013-graph97-en>.

Finding 4.

Australia's business R&D tax incentive could be adjusted to encourage collaboration with public sector researchers

A number of the countries reviewed are using R&D tax incentives to encourage collaboration with public sector research institutions. Countries that have adopted this approach have higher rates of business collaboration with public sector research institutions. Examples of such countries include Denmark and Chile. This suggests that a more favourable incentive for such collaboration is an effective incentive for business. Australia's R&D tax incentive could be adjusted to provide companies with a greater benefit for collaborative work with public sector researchers.

There is also a case for the use of loans in conjunction with grants. Section 2.12 discusses mixed grants and loans support. Appendix C summarises details of a range of different loan schemes in other countries. These schemes recognise that start-ups are not able to make repayments until they have established a positive cash flow (i.e. they have crossed the 'valley of death'. The unwillingness of banks to lend to start-up companies and the importance of growing these companies justify government intervention.

In Australia there have been proposals to use contingent loans to support innovation in Australia in ways with low administrative costs similar to Australia's HECS scheme (Withers and Chapman, 2015). In the 1980s, Section 39 of the Commonwealth Industrial Research and Development Act financed early stage development of the bionic ear by Professor Graeme Clark and his colleagues. This support was subject to a requirement to make a royalty-type payment to the Government in the event of success. Subsequently, these payments by Cochlear Ltd are estimated to have repaid the total cost of the Section 39 program several times over.

3.2.2 Incentives for public sector researchers

Australia's ARC and NHMRC have programs to encourage public sector researchers to engage in research collaboration. The operation of these programs should reflect the leading practice principles described in this report. There have been reports of some linkage-type grants where there has been no engagement between the public sector researchers and the external party during the course of the project. The fact that more than 50 per cent of ARC Linkage Grants are awarded to projects that do not involve a business or industry partner is a cause for some concern.

Finding 5.

Increasing funding for research collaboration programs and requiring rigorous engagement between the parties involved will increase research translation in Australia

There is a need to reform Australian research collaboration programs, such as ARC's Linkage Programs, by increasing funding and adopting the leading grant administration practices of programs reviewed for this report. To obtain optimal benefit from these programs, grant recipients should be required to adopt a milestone based approach to project management, develop IP strategies, and ensure active collaboration between all parties. For larger projects, grant payments should be made against the achievement of milestones.

At the same time, government should be encouraging universities to shift from project-based collaboration to building more substantial longer-term partnerships with external parties (including business and not-for-profits).

The Australian Academy of Technological Sciences and Engineering (ATSE) has explored options for metrics to measure Australian universities' research engagement with private and public sector partners. This work is intended to ensure that research engagement is appropriately recognised and rewarded alongside research excellence (ATSE, 2015). The proposed metrics are derived from existing data collections of

Australian university research. They are based on external dollars attracted to support research from industry and other ends users, as a direct measure of research engagement. The metrics, which have been developed using the Australia and New Zealand Standard Research Classification (ANZSRC) two-digit Field of Research (FoR) codes, have been named 'Research Engagement for Australia' (REA). Measuring engagement can enable it to be rewarded in similar ways to the UK's HEIF scheme (see Box 2.16).

The use of *Pathways to Impact* statements in relation to grant applications to the UK's Research Councils is a measure that could help to change researcher attitudes to engagement. The UK Research Councils provide advice and toolkits on their websites to help grant applicants comply with this requirement. This measure is discussed in Box 3.1. It is important for Australia to continue to develop and evaluate metrics for assessing, encouraging and rewarding research translation.

As noted in Section 2.5 the UK, Canada and some other countries have adopted specific measures to encourage engagement on the part of researchers in the humanities arts and social sciences (HASS).

Finding 6.

Measures to encourage public sector researcher engagement can be structured in ways that create opportunities for those in the humanities, arts and social sciences

The engagement of researchers from HASS disciplines has opportunities and challenges that are different to those of the science and engineering disciplines. For these reasons, some countries have adopted specific measures to encourage HASS engagement and collaboration. Whether or not such specific measures are adopted in Australia, it is important to ensure that HASS researchers are not excluded from generally available measures to encourage public sector researcher engagement with external parties.

3.2.3 Measures involving students and recent graduates

Measures such as the UK's Knowledge Transfer Partnerships (KTPs) provide a low cost means of getting new graduates into SMEs. These graduates bring up-to-date skills and ideas. The fact that many of them are offered jobs by the firms they work with is a strong indicator of success. The involvement of university supervisors is also involved is also a positive factor, and can lead to ongoing collaboration. Queensland is planning to introduce KTPs. There is a case for Australia to do so on a national basis.

The Australian Government's Entrepreneurs' Program provides some support for commercialisation activities including "the placement of a researcher in the business in

Box 3.1: Research Councils UK *Pathways to Impact* statements

The UK Research Councils require an acceptable *Pathways to Impact* statement before a research grant recipient can start work. The Research Councils provide advice and information kits on their websites. The impact sections of grant applications need to provide a short impact summary which explains:

- Who is interested in the research?
- Why are they interested? What are their agendas?

In addition, the *Pathways to Impact* statement has to address the following questions in a two A4 page document:

- How is the grant recipient going to engage external stakeholders?
- What will the grant recipient do to connect with them?
- Why are the chosen channels appropriate?
- What evidence is there to indicate that this will work?
- When will these activities take place and what is the rationale?
- How much will these activities cost (sufficient provision has to be made in the budget)
- Who is going to manage this part of the project and what experience do they have?

Grant recipients are expected to keep the *Pathways to Impact* statement updated during the course of the project.

order to develop and implement a new idea with commercial potential” which appears to be the successor to the *Researchers in Business* Program. *Researchers in Business* was widely considered to be successful but the scale of the program has been too small and the marketing inadequate. This is an example of an Australian program where a change of name has resulted in loss of brand recognition and the inadequate marketing and funding of its predecessor.

Encouraging student entrepreneurship has emerged as a new dimension of knowledge transfer (OECD, 2013a). This has led universities to create business incubators, provide entrepreneurship courses and establish investment funds to provide capital to start-ups.

Finding 7.

Australia can increase research translation through the placement of students and new graduates in business and other organisations

Programs that support the project-based placement of students and new graduates within external organisations will help to transfer new creative and technical skills to the business, government and not-for-profit sectors. Work integrated learning placements can also help build relations between universities and external parties that can lead to future collaborations.

The UK’s Knowledge Transfer Partnerships Program has been identified as a leading practice measure to increase links between universities and business, to translate research outcomes through the knowledge and skills of new graduates, and to increase the recruitment of science and engineering graduates by business. Australia could establish a similar program, with resources and commitment on a scale comparable to the UK. Under such a program, placements could involve students and new graduates from all disciplines including the social sciences, humanities and the arts.

3.2.4 Incentives for public sector collaboration with external parties

Measures that require a joint proposal from public sector researchers and external partners (often business) are one of the most preferred approaches. There are several reasons for this:

- Such measures require the collaborating parties to have come to an agreement about their objectives and how they will work to achieve them.
- In developing a research plan, the external party has been given the opportunity to inject a commercial perspective into the timing, the managing of risks, the likely behaviour of competitors, etc.
- The collaborating parties are usually expected to provide a clear indication of the outcomes that they expect to achieve and the likely value of those outcomes to business and/or society.
- Arrangements for the assignment and management of IP rights are settled before work commences.
- In a competitive grants process, the panel deciding the grants can have confidence in assessing the merits of the proposal because of the factors listed above.
- The outcomes of such collaborations can be readily evaluated.

Australia’s Cooperative Research Centres (CRC) Program meets the above criteria. The CRC Program is designed for commitments up to seven years (and has sometimes been extended beyond that period). This scale of funding is designed to support serious longer-term collaboration.

Some CRCs have found it challenging to engage with SMEs because it is often difficult for smaller firms to make long term financial commitments. However there have been examples (such as the Advanced Manufacturing CRC) that have found practical ways to involve SMEs. The Low Carbon Living CRC has introduced the UK’s Engineering and Physical Sciences Research Council (EPSRC) ‘sandpit’ methodology as a means of identifying SME needs and project opportunities (EPSRC, 2015).

Finding 8.

Increased assistance for collaborative research will enhance translation in Australia

Research collaboration between public sector researchers and external parties is an important means of transferring knowledge and skills. Many of the countries reviewed for this project have programs that are similar to Australia's Cooperative Research Centres (CRC) Program, designed to bring together public sector researcher, industry and other partners. Most other countries provide this type of support on a larger and more generous scale than Australia. Australia needs a range of university-business collaboration models that includes research centres, networks, clusters, hubs, precincts, and better-funded CRC and Linkage Programs.

3.2.5 Incentives for university administrations

As the US National Academy of Science (NAS) observed in their report on managing university IP in the public interest:

Discovery, learning, and societal engagement are mutually supportive core missions of the research university. Transfer of knowledge to those in society who can make use of it for the general good contributes to each of these missions.

NAS (2011)

Although the means of this transfer of knowledge may vary:

The goal of expeditious and wide dissemination of discoveries and inventions places IP-based technology transfer squarely within the research university's core missions of discovery, learning and promotion of social well-being.

NAS (2011)

This view that universities have responsibilities in relation to the translation of research is not limited to the USA. The policies and programs of the countries examined for this report are based on similar premises to those espoused by the US NAS.

Some countries have decided to define the responsibilities of universities in legislation. The European Commission (2008) has issued a recommendation on the management of IP in knowledge transfer activities and a Code of Practice for universities and other public research organisations. The Commission notes that the active engagement of public sector research organisations in intellectual property management and knowledge transfer is essential for getting socio-economic benefits. The Code of Practice emphasises the need for public sector research-performing institutions to adopt long-term strategies for the management of IP and knowledge transfer.

In Australia, the ARC and NHMRC have issued National Principles of Intellectual Property Management for Publicly Funded Research (ARC, 2015). The principles place obligations on Australian research institutions in relation to Commonwealth Government competitive grant funding which requires them, in summary, to:

- make every reasonable effort to gain benefit for Australia from IP
- take initial ownership of IP rights resulting from competitively funded research
- adopt and implement policies relating to ownership and availability of IP from this research
- assist the management of IP by assisting researchers to meet their obligations under the principles, and
- provide systems to identify manage and record this IP.

The most important example of an incentive provided to universities in other countries is the UK's HEIF (third stream funding—see Box 2.15). This provides a relatively small but significant incentive to universities to increase their engagement with outside parties. It is a measure that could readily be adopted in Australia.

Finding 9.

Providing targeted incentives to Australian universities is a proven method of increasing their engagement with external parties

Incentives to increase university engagement need to recognise the breadth of interactions between universities and external parties, which go well beyond commercialisation of research. Other forms of engagement are also important and can involve all disciplines, including the humanities, arts and social sciences.

Introducing metrics for university engagement with external parties, and rewarding this engagement has played a key role in increasing research translation in the UK. The UK is a leading practice country in terms of engagement incentives for universities. It provides support for university engagement through Higher Education Innovation Fund (HEIF). The evidence shows that HEIF has generated jobs and economic growth. Another UK initiative, requiring *Pathways to Impact* statements for research grant applications, is also bringing about change in public sector researcher attitudes to engagement with external parties.

3.2.6 Measures to strengthen technology transfer offices

Leading practice supports university TTOs in developing broad engagement strategies with businesses and governments. Chile, Brazil, Israel, Sweden and other countries are providing support for TTOs. This is helping them to overcome problems including a lack of critical mass, lack of breadth of expertise and difficulties in accessing finance. There are examples of links between offices and hub and spoke arrangements and other forms of alliances to overcome some of these challenges (OECD, 2013a). In the UK the recent Dowling report stated:

Technology transfer offices need to prioritise knowledge exchange over short-term income generation, and further work is required to improve approaches to contracts and IP agreements.

Dowling (2015)

France has established a fund to create Technology Transfer Acceleration companies (SATT) to reduce fragmentation of technology transfer services (OECD, 2013a).

Most TTOs do not break even, in terms of costs versus revenues from licensing. Universities that see the translation on research as part of their mission should not have a problem with this—but some do. In many countries, the operating costs of the TTO are seen as simply part of a university's cost of doing business.

TTOs have traditionally been measured by the number of start-ups that they have created and the income received from licensing patents. The US-based Association of University Technology Managers (AUTM) is a not-for-profit organisation that supports the global university technology transfer profession through education, professional development, partnering and advocacy. AUTM has more than 3,200 members representing managers of intellectual property from more than 300 universities, research institutions and teaching hospitals around the world, as well as numerous businesses and government organisations. AUTM's surveys of the performance of its members are frequently cited.

However it needs to be remembered that the value to society from the translation of university research is very much greater than the licensing revenues of university technology transfer organisations. In recognition of too much focus being given to revenue generation as a measure of Technology Transfer, AUTM introduced the Better World Project to capture and demonstrate the societal and other impacts flowing from research. Introduced in 2006, the project aimed to move the focus from income to impact (AUTM, 2015). Whilst Better World is viewed positively, the emphasis on revenue as a measure remains fairly entrenched in the US system.

Some government laboratories (such as CSIRO) have commercial managers embedded in the organisation who get involved in relationships with companies from the early stages of research projects. This is a leading practice approach because engaging with commercial partners from the early stages of research projects has been shown to be more likely to lead to the eventual translation of the results into economic

and social benefits. Such relationships can inject an element of commercial reality into research projects as they progress.

Australian TTOs lack access to the broad range of training available to US, UK and European universities and have limited access to those due to travel costs. Knowledge Commercialisation Australia has now developed three core courses in Australia which meet the international standard set by the International Alliance of Technology Transfer Professionals (ATTP), but are resource limited in developing broader and deeper training provision. A Commonwealth Government funded program to strengthen the performance of university TTOs would address this issue. The aims of such a program would be to enable and support further professional development for TTOs.

3.2.7 Measures addressing intellectual property issues

In most countries, how licensing revenues are shared between the university, the researchers and the TTO is a matter for individual universities to determine. The sharing of revenues needs to take into account the cost of developing an IP strategy, IP protection and negotiating a licence. It also needs to provide an incentive to the researchers involved, who are often needed to help in the licensing process.

As noted above, the ARC and NHMRC National Principles of Intellectual Property Management for Publicly Funded Research do not place obligations directly on the researchers involved. This is left to the universities and research institutes to manage.

Licensing IP can be a source of revenue for universities, but to achieve this requires specialist professional skills. The Licensing Executives Society (LESANZ) runs training courses that cover the different approaches to licensing and the issues that need to be considered. University TTOs usually have some in-house capability, which can be augmented with outside professional advice when necessary.

3.2.8 Measures to assist university start-up companies

As noted earlier in this Chapter, start-ups are one option for commercialising public sector research. To have a chance of success there are a number of pre-requisites. These include IP and business strategies, an analysis of market prospects, finance and other commercial inputs and the willingness of researchers to continue to assist the development process. When these pre-requisites are met, it is appropriate that some government support should be available. Most of the countries reviewed assist the establishment of start-up companies from universities and, in some cases, also from government laboratories.

The amounts of funding available for this purpose in a number of the countries reviewed are impressive. For example, Germany provided \$A51 million in 2012 and while the Israel Government investment in start-ups is not publicly known is believed to be in excess of \$A0.5 billion. In both cases, there are very carefully designed milestone payments to ensure that private sector investment is brought in at the earliest stage appropriate and that government assistance is tapered as the company gets established. Given the shortage of capital for start-ups in Australia, a measure of this type could be very successful in helping start-ups from universities and government laboratories.

It should be stressed that, in most dynamic start-up ecosystems, the vast majority of start-ups are led by students and alumni rather than university staff. Stanford, MIT and the Weizmann Institute start-up systems are dominated by a demand from entrepreneurial alumni. The burgeoning student start-up system in Australia presents opportunities to create this same sort of ecosystem, particularly given the existence of a very strong incubator/accelerator system outside the universities into which student start-ups with potential can be assisted to grow.

3.2.9 Measures addressing the capital needs of new technology-based companies

In Australia, universities have rarely provided capital to start-ups (the one exception being Uniseed Ltd). Universities sometimes contribute IP in return for an allocation of shares in a start-up. However when further funds are raised, unless the university provides further funding, its shareholding is diluted.

Some universities and publicly funded research organisations are setting up their own funding mechanisms for start-ups to complement government support (OECD, 2013a). Israel's programs to support promising university projects up to the stage where private sector investors can take over are very carefully structured. The selection processes are rigorous. Payments are subject to milestones which include steps to get supported projects investment-ready. In the current environment where early stage capital is in very short supply, a program similar to those operating in Israel would fill a significant gap.

Uniseed Ltd is a venture fund operating at the Universities of Melbourne, Queensland, and New South Wales; with investment capital provided by the three universities. Uniseed's mandate is to facilitate the commercialisation of university-generated intellectual property by targeted investment in highly promising technologies. Uniseed's investments cover a range of technology sectors. To date, the fund has exited six investments with four of these through trade sales as well as one asset sale and an IPO. Its biotechnology portfolio is maturing, with a number of companies in clinical trials (Uniseed, 2015). Government support for funds such as Uniseed could see the increased availability of early stage finance to take public sector research to the market.

The problem of finding capital for start-up companies in Australia is not limited to spin-outs from universities and government laboratories. However it is likely that investors are more wary

of this latter group because of concerns about the commercial abilities of those involved. Singapore's provision of dedicated investment funds is a useful example of a measure targeted at universities.

This report provides examples of government owned financial institutions with responsibilities that include providing capital for start-ups and SMEs with strong growth prospects. These generally operate at arm's length from government to avoid making investments on grounds other than commercial prospects. The Australian Technology Group Ltd fulfilled this type of role in Australia but it no longer exists.

Finding 10. **Measures to support the financing of commercial outcomes from public sector research would address a major gap in Australia's innovation system**

Many of the countries examined in this report have adopted measures to help the outcomes of public sector research find their way to the market. Examples include Singapore's Early Stage Venture Fund, Japan's A-STEP and Germany's SIGNO Program. Australia lacks sources of capital to enable commercialisation of outcomes from public sector research. Governments in other countries such as Israel and Denmark facilitate or provide such capital. The US Small Business Innovation Research Program is another example.

Programs that offer combinations of grants and loans to SMEs with strong growth potential should also be considered. Finland's Tekes has a multi-phase program to support young innovative companies. This is a leading practice example of combining grants and loans.

3.2.10 Innovation intermediaries

Innovation intermediaries have proved their worth in several countries. Although generally government-supported, they operate at arm's length from government. They are ideal for managing voucher schemes where the allocation of the voucher is based on a diagnosis of the

sort of help that the client needs. Vouchers for access to publicly funded research need to be accompanied by advice on where to go for help. This means that intermediaries need knowledge of potential research partners. Given their role to provide localised assistance, they should receive state government support. However to be effective, intermediaries need to be supported over the longer term. Suspending Victoria’s voucher program has resulted in a loss of continuity and experienced advisers that will be difficult to replace if and when the Government decides to again support the program. As the Dowling report has noted, “effective brokerage is crucial, particularly for SMEs, and continued support is needed for activities that help seed collaborations” (Dowling, 2015).

Finding 11.

Greater use of innovation intermediaries would enhance collaboration and increase research translation in Australia

Innovation intermediary organisation can facilitate the flow of public sector research skills and knowledge to SMEs. They can interpret research findings for businesses and articulate to researchers the needs of businesses in ways each of these parties cannot. However they need to be adequately funded if they are going to make a difference and it will take some time for these organisations to have measurable impact. As such, bipartisan support for their development

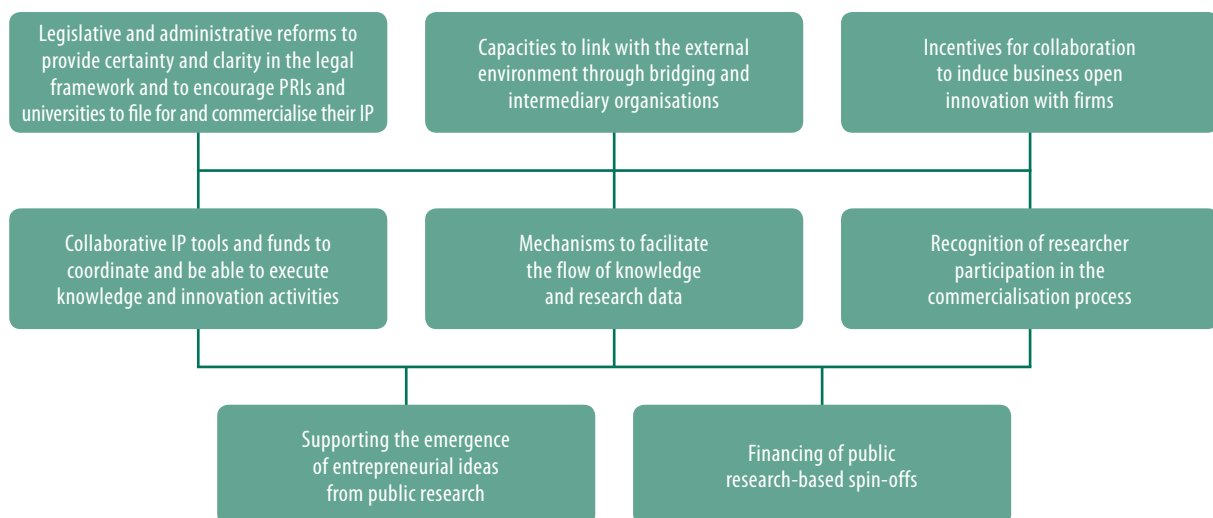
and operation is essential to ensure that stable funding and support for these organisations is provided. The UK’s Catapult Centres seek to align industry, university and government needs. Scotland’s Interface Program provides another leading practice example of an intermediary organisation.

3.3 A strategic approach to enhancing research translation

As the OECD has noted (OECD, 2013a), initiatives to enhance knowledge transfer and commercialisation of public sector research need to be multifaceted, incentivise multiple actors and work on multiple levels. A coherent, systems approach is needed. Universities, government and public sector research institutes all have roles to play. The OECD reports a mix of top-down measures from government accompanied by bottom-up initiatives at the public research organisation level. The OECD’s strategic framework for this is shown in Figure 3.2. It illustrates the various components of a strategy for enhancing translation of research.

In the countries studied, research translation is an important element of a suite of coherent policies designed to further the development of industry and the application of science. It is explicitly

Figure 3.2: Strategies for enhancing the transfer and commercialisation of public sector research



Source: Adapted from OECD (2013a).

recognised that national competitiveness and productivity relies on innovation that can be enhanced when research is effectively translated into industry.

In many countries in Asia and Latin America, innovation and research translation are seen as crucial contributors to economic development. In developed economies, research translation is seen to enhance existing industries and assist diversification into new areas. In the United Kingdom, for example, innovation policy assists the rebalancing of its economy away from its reliance on the financial sector. In Finland, innovation policy has helped build the resilience that has allowed that economy to survive the decline of Nokia, its major corporation. In each of the countries studied, the various programs and policy supports in place for research translation are components of, and are guided by, a national vision for its wider purpose and contribution. The contrast with Australia is stark, and our review shows how our policies and supportive programs are piecemeal, opportunistic and almost invariably short-lived.

Effective institutional arrangements for innovation are essential to improving the translation of public sector research. Research translation needs to be a key element of a national innovation strategy. Leading practice countries described in this report have such a strategy, which provides a reference point to guide the selection of policy and program options. Translation strategies need to provide a mix of incentives aimed at researchers, business and other parties. For example, Germany's High-Tech Strategy describes five core elements of a consistent innovation policy and addresses implementation issues such as cooperation between the Federal and Länder (state) governments (BMBF, 2014b). In the UK, the Dowling report noted that "government strategy on innovation needs to be better coordinated and have greater visibility" (Dowling, 2015).

In many of the countries studied, policy development and implementation in this area is

the responsibility of key independent agencies. Examples can be found in countries that are innovation leaders such as Finland's Tekes, Sweden's Vinnova and the United Kingdom's Innovate UK. It is to be noted these countries find considerable value in the longevity, high profile and investment approach used by these organisations. Their high visibility to industry and research organisations, and their competence developed over many years of operation, assists building the strong relationships and trust necessary to help overcome the difficulties of research translation.

These organisations are given a mandate by, but operate at arm's length from government. In some cases they are statutory bodies and in other cases they are government-owned corporations. They use a business-based approach to the management of measures under the responsibility. The United Kingdom's Innovate UK is best suited to the Australian context and is described in more detail in Appendix D. National innovation agencies in the United Kingdom, Finland, Denmark and Israel are discussed in Box 3.2. Appendix A summarises details of similar agencies in Brazil, Chile and Korea.

Finding 12.
Australia can emulate leading countries' consistent support of successful research translation by adopting a coherent national strategy for innovation and establishing a national innovation agency to manage it

Countries achieving high levels of public sector research translation provide a sound institutional context for this activity by making it a key element of a national innovation strategy. Most leading practice countries have well-resourced and coordinated innovation strategies, which provide a reference point to guide the selection of policy and program options. Such strategies can define which measures are best addressed at a national level and which are better delivered by sub-central government. They can also help to minimise overlap and duplication between levels of government.

In many of the countries reviewed, the delivery of national innovation strategies is the responsibility of an independent agency, which operates at arm's length from government. Australia can look to successful innovation agencies, such as Finland's Tekes, Sweden's VINNOVA and Innovate UK as models for an Australian innovation agency.

Initiatives to enhance research translation need to be multifaceted, incentivise multiple actors and work on multiple levels. When these initiatives are part of a national innovation strategy and are based on a coherent set of policies, they can achieve real results. The establishment of a national innovation strategy and an implementation agency needs bipartisan support.

Box 3.2: National Innovation Agencies

Finland's Funding Agency for Technology and Innovation (Tekes)

Tekes was founded in 1983 and is the national public funding agency for research funding in Finland. Tekes is an independent statutory body with a government-appointed Board. Tekes does not see itself as a funding agency. Rather it is a highly interventionist intermediary which uses its resources to shape knowledge-based business (Johnston, 2015b). One of the conditions of Tekes funding for large companies is research cooperation with SMEs, research institutes and universities (Tekes, 2012).

In 2015, there are 16 Tekes programs in operation (Johnston, 2015b). The 2014 Tekes budget was €550 million (approximately \$A883 million). Tekes has been the subject of regular reviews, and actively reports its achievements across all programs. For example, for 2014:

- For every €1 invested by Tekes, companies increase their R&D investment by €2.
- SMEs expect projects to produce €5.8 billion in turnover.
- For SMES funded by Tekes, the annual growth of exports was €1 billion.
- More than 80 per cent of Tekes clients whose innovation activity has been successful state that Tekes funding was a significant factor in their success.
- Over 50 per cent of SME projects funded by Tekes are commercially successful.
- In growth companies funded by Tekes, the rate of turnover growth between 2010 and 2013 was 24 per cent greater than other SMEs.
- Projects resulted in 1,130 patents or patent applications.
- Projects generated 1,500 products, services or processes.
- Nine of the ten fastest growing companies in Finland were Tekes customers.

3.4 Leading practice policies

It is evident from the research undertaken for this project that there are a number of leading practice principles that apply to measures to encourage research translation. These measures are most effective when they are part of a well-coordinated and resourced national innovation strategy.

3.4.1 Leading practice policies at government level

At government level, these principles include:

- Program stability—most of the measures in use in other countries have been in place for many years. In some cases program guidelines and

Sweden's Agency for Innovation Systems (VINNOVA)

VINNOVA, founded in 2001, executes innovation policy on a national level through funding of needs-driven R&D as well as strengthening networks. In 2012, VINNOVA was appointed central coordinator of the effort of eleven other governmental agencies in relation to their innovation activities. The Ministry of Education and Research and the Ministry of Enterprise, Energy and Communications are largely responsible for research and innovation policy. In 2012 they published a National Innovation Strategy. VINNOVA is responsible for monitoring the implementation of the Strategy.

The Swedish Government has tasked VINNOVA to:

- make Sweden a leading research nation in which research of high scientific quality is conducted
- promote sustainable growth and increased employment by acting to increase competitiveness and the emergence and expansion of successful companies
- support research and development work of the highest quality in areas such as engineering, transport, communications and working life in order to promote renewal and sustainable growth
- stimulate Swedish participation in European and international R&D collaboration and in the exchange of experience in the field of innovation.

VINNOVA's current budget is SEK2.7 billion (approximately \$A458 million) (Taftie, 2015), however many of its programs are co-financed with other agencies, so this figure understates VINNOVA's influence.

administrative practice have evolved over time, often as the result of evaluations and reviews. However the core purpose of the measures has been maintained as has, in nearly all cases, the branding. Business, in particular, does not welcome frequent changes in the names and rules of support programs.

- Program continuity—starting and stopping programs causes major interruptions to the activities that programs seek to encourage. A lack of certainty and continuity destroys longer term planning in research translation. Businesses are not going to enter into discussions about research translation projects if there is any doubt over continuity of funding.

- Evaluation of measures—most countries reviewed undertake regular evaluations of their measures to encourage research translation. This often results in minor adjustments to eligibility requirements and levels of support. Most countries make their evaluations public.

Finding 13.

Independent reviews and evaluations of research translation measures are necessary to ensure that they are achieving their objectives

The project has found that leading practice countries regularly commission independent evaluations of innovation and research translation measures and make the evaluations

The United Kingdom's Innovate UK

Innovate UK (formerly Technology Strategy Board) was incorporated by Royal Charter and is responsible for the funding of activities to accelerate economic growth. It takes a business-led approach to innovation. Around 30 per cent of Innovate UK's grant funds go to partners in the higher education sector research base and around 60 per cent of the projects it funds involve collaboration with higher education institutes. The most important activity is focused around collaborative R&D, which had a £173 million budget in 2013–14.

Members of Innovate UK's Governing Board are appointed by the Secretary of State for Business, Innovation & Skills and are drawn from business, the public sector and research communities. Since 2007 Innovate UK has invested £1.5 billion (approximately \$A3.25 billion), with a further £1.5 billion from business and partners. This has helped many thousands of companies and is estimated to contribute more than £7 billion of extra value to the economy and more than 35,000 new jobs (Innovate UK, 2015b). For more details on Innovate UK's structure and activities, see Appendix D.

Denmark's Innovation Fund

In 2014, Denmark merged various institutions in charge of technology and entrepreneurship policy into a single agency—the Innovation Fund Denmark (IFD). The Danish National Advanced Technology Foundation, the Danish Council for Technology and Innovation, and the Danish Council for Strategic Research were amalgamated into this new Foundation. It has a government-appointed Board. In 2015, IFD will invest almost DKK1.6 billion (approximately \$A271 million) (IFD, 2015).

IFD's investments aim to stimulate growth and employment, and to provide solutions to key societal challenges. It seeks to achieve its objectives by means of:

- Innovation and technological advances
- Interdisciplinary alliances
- Thriving entrepreneurship
- Research excellence
- A dynamic international outlook.

Innovation Fund Denmark invests in cultivating and translating ideas, knowledge and technology for the benefit of Danish Society. Its mission is to ensure that entrepreneurship, partnership and an international outlook thrive so that ideas, knowledge and technologies may be translated into viable businesses and innovative solutions for the benefit of society.

Israel's Office of the Chief Scientist

The Office of the Chief Scientist (OCS) was established in 1969 and is the main government agency to support R&D. Although the OCS sits within the Ministry of Industry, Trade and Employment, it is reported to have a high degree of autonomy. It advises on policy aspects of governmental support for R&D and evaluates programs. It also administers government programs. The current budget of the OCS is understood to be in excess of \$US0.5 billion per annum.

Funding is given for a broad range of local and international competitive research frameworks and is mostly provided to companies, but also individuals in some cases. Israeli science, technology and innovation policy follows a bottom-up approach with specific policies in various areas rather than an overall national strategy that guides science, technology and innovation policy orientations. A formal platform is under development in order to involve policy shapers and implementers (OECD, 2014c; Shahaf, 2015).

public. For example the UK's Knowledge Transfer Partnerships Program has undergone a number of independent evaluations over its 40-year existence. Program reviews can demonstrate the benefits of successful measures. Israel's Magneton Program underwent an independent review in 2009, which found that around 80 per cent of projects involved a high level of innovation and achieved breakthroughs or new knowledge. In leading practice countries, adjustments to policies and programs are informed by such evaluations. Australia should use independent reviews and evaluations to ensure the continual effectiveness of research translation measures.

- Minimal bureaucracy—researchers and their collaborators accept that, with public funding there comes some accountability obligations. Collecting data from program beneficiaries each year is necessary to inform evaluations and reviews. The data collected should be sufficient to do this and collected in a way that minimises the effort required on the part of beneficiaries. The German ZIM Program came about as a result of the combining of several previous programs.
- Funding at a level that is sufficient to make a measurable difference—taking the account of size of the economies discussed in this report, the levels of funding for similar programs in Australia appear to be well below that of comparable measures in other countries.
- Incentives for engagement—rewarding universities and public sector research institutes for their engagement activities provides an incentive for greater research translation. It counterbalances the disincentive that can arise from the quest for research quality through measures such as Australia's ERA (ATSE, 2015). The UK practice (providing rewards to universities rather than to individual researchers) encourages universities to take a strategic approach to engagement.

3.4.2 Program-level leading practice policies

In relation to individual measures to encourage research translation, leading practice includes:

- Business leadership of collaborative activities—as a general rule, the party that is to generate economic or social benefits from engagement or research translation should be the one to lead the project and receive and manage grant funds from government. Thus in joint business-public sector researcher projects, government funding should flow to the business, which then passes funds on to the researchers according to an agreement established at the start of the project.
- Cost sharing—where business is expected to gain benefits from research translation, business should make some contribution to project costs. The extent of the contribution required from business should reflect the risk involved and the scale of government support. For example, programs that target support over the 'valley of death' involve greater risk and justify higher levels of government assistance. Simply requiring business to match government funding is a one-size-fits-all approach which is no longer seen as appropriate.
- Research partnerships—effective research engagement and translation requires the active involvement of both the public sector researchers and the would-be beneficiaries, working in partnerships. Without active collaboration the prospects of successful research translation are greatly reduced. Research performed by public sector researchers under contract from external parties has its place, but often does not involve real collaboration.
- Working in industry facilities—public sector researchers engaged in research collaboration and translation should, wherever possible, spend time working in industry facilities in order to gain a better understanding of the environment in which the outcomes of the research will be applied.

- Support for commercialising research—this report identifies a number of examples where researchers are supported to undertake further research in order to get their work to the point where an external party might support the project into an application phase. Government support of pre-commercial research needs to be subject to the development of an IP strategy, an analysis of market prospects and the identification of, and preliminary discussions with, potential development partners.
- Appropriately skilled selection committees—grants for research claiming to have translation potential should be decided by committees that include business and translation experience. In addition, where these committees are asked to assess proposals across a range of disciplines, either external advice is needed or the disciplines need to be represented in the committee membership.
- Rapid assessment of translation proposals—proposals for the support of research collaboration need to be assessed quickly and preferably continuously. Conducting calls for proposals once or twice per annum is not leading practice. Without a quick turnaround, companies lose interest.

3.4.3 Public research institution leading practice policies

Leading practice for public research institution involvement in research translation includes:

- Recognition that engagement and research translation are an integral part of university missions. The mission statement of MIT is:

The mission of MIT is to advance knowledge and educate students in science, technology, and other areas of scholarship that will best serve the nation and the world in the 21st century. The Institute is committed to generating, disseminating, and preserving knowledge, and to working with others to bring this knowledge to bear on the

world's great challenges. MIT is dedicated to providing its students with an education that combines rigorous academic study and the excitement of discovery with the support and intellectual stimulation of a diverse campus community. We seek to develop in each member of the MIT community the ability and passion to work wisely, creatively, and effectively for the betterment of humankind.

MIT (2015)

- Interestingly, there is no mention of earning revenue from research in the MIT mission statement. Clearly, mission statements such as that of MIT require a strong TTO.
- Strong technology transfer arrangements—many public sector researchers lack the relevant expertise and skills to find potential partners. For this reason, universities and public sector research institutes find it necessary to appoint dedicated personnel to facilitate the translation of their research, through technology transfer offices, industry liaison offices, units or companies (TTOs). Their staff face a difficult task because of the breadth of the disciplines that need to be covered. Until recently there has been little specialised formal training available for such staff. High staff turnover has also been a problem. Supporting the operations of TTOs and the training of their staff is a sound investment.
- Ensuring that TTO and other research management functions are well coordinated—the report on Australia prepared for this project indicates that Australian TTOs are following a world-wide trend (OECD, 2013a) and broadening their focus to engagement rather than prioritising licensing and start-ups. This same trend can be observed in some of the country reports prepared for this project. TTOs also need to be involved in the negotiation of collaboration agreements such as those required for ARC Linkage projects and in the preparation of the IP strategies noted above.

- Creation of start-up companies—there are limited opportunities to establish start-ups based on public sector research. Licensing is often a more attractive route (Shane, 2004). To be viable, such start-ups require ongoing commitment from one or more researchers, business skills (that researchers do not usually have) and capital investment. Start-ups also need an invention with strong commercial prospects, an IP strategy and government support, as the examples in Chapter 2 show very clearly.
- Collaboration agreements—one of the major problems in achieving greater research translation has been the difficulties that external parties have experienced in establishing collaboration agreements with public sector researchers. There is a tendency for researchers and universities to over-value their research outcomes and under-value the risks and costs associated with getting research outcomes to market. Some examples discussed in Chapter 2 require the IP rights to be assigned to the external party as a condition of government assistance. Another approach is that adopted by the University of NSW in Australia, with one-page plain English agreements and, with some IP, no licence fees. There are model collaboration agreements available, but they need to be tailored to the circumstances of individual projects. This requires specialist skills.

Finding 14.
Streamlining internal university policies and procedures can improve university engagement with business and other external parties

Many universities in other countries have simplified and streamlined arrangements for collaboration between businesses and

university faculties, research centres and staff. Australian universities should ‘fast-track’ approval procedures, review of delegations, and appoint executive staff with business experience to facilitate engagement with external parties.

- Researcher training in translation and entrepreneurship—providing training for researchers in the skills of innovation and research translation, collaboration and entrepreneurship is a feature of leading universities in Europe. It is most important at the Master’s degree and PhD stages.

Finding 15.
Assisting the development of research translation and entrepreneurial skills in Australia’s public sector research institutions will improve their performance

Several countries that have been reviewed for this project have provided targeted assistance to develop research translation skills in public sector research institutions. For example, Chile’s Program to strengthen human capital for technology transfer is improving the performance of research commercialisation in its research institutes and universities. Such skills development should not be limited to university technology transfer office staff.

Providing university students with opportunities to develop entrepreneurial skills as part of their studies is a means of increasing interest in start-up company formation. Germany for example, developed The Start-ups from Science (EXIST) initiative to improve the entrepreneurial environment at universities and research institutes. Government can assist public sector research institutions by providing support for innovation contests, start-up programs (including incubators and accelerators), internships and placements, and innovative workspaces.

3.5 Conclusions

This Chapter has discussed some contextual factors which need to be taken into account when considering adapting policy measures and programs from the other countries discussed in this report. Table 3.1 shows that some countries with significantly smaller GDPs than Australia are making much bigger investments in research translation.

Based on an analysis of the programs of fourteen countries, this Chapter has identified leading practice in relation to research translation.

This analysis has been informed by consultant reports, which include discussion of reviews and evaluations of the measures described. Leading practices have been described at the level of government, individual policies and programs, and at research institution level.

The consultant reports have identified very few examples of measures to encourage research translation that had not worked. However some examples were found where, as a result of an evaluation, improvements had been made. These improvements included a change of name (Teaching Company Scheme to Knowledge Transfer Partnerships), streamlining of grant

application and management procedures (ZIM) and amalgamation of funding bodies (Innovation Fund of Denmark).

The Chapter has identified a strategic approach as the key to encouraging innovation and, more particularly, successful research translation. To deliver such a strategy in an effective and efficient way is best done through a specialist agency such as Innovate UK or Tekes (Finland).

Leading practice measures for research translation have been examined to determine the most effective incentives to encourage engagement of each of the stakeholders: researchers, students and graduate, business and universities. The role of TTOs, intellectual property issues, start-up companies, innovation intermediaries and the provision of early-stage capital have all been discussed.

In all of these areas, there is scope for Australia to learn from the experiences of other countries and to adopt or adapt some of the measures described in order to provide a well-designed, integrated suite of measures that can greatly improve research translation.

Appendix A

Measures described in country reports

Australia		
Cooperative Research Centres (CRCs)	<p>The Cooperative Research Centre Program was established in 1991 to facilitate and support industry led collaborations between researchers, industry, and community. In 2015–16 there are 34 operational CRCs in areas as diverse as hearing, healthcare, pest management, bushfire and natural hazards management, financial markets security, and the auto and aerospace industries. The CRC Program is administered by the Department of Industry, Innovation and Science and has a budget of \$146.75 million in the current financial year (Howard, 2015).</p> <p>A recent review of the Program was positive but identified a number of recommendations aimed at refocusing the program, lifting its performance and streamlining administration (Miles, 2015).</p>	Supports collaboration between universities and other parties
Australian Research Council (ARC) Linkage Program	<p>ARC's Linkage Program provides a range of funding schemes that encourage cooperative approaches to research and increase the use of research outcomes. The Program promotes and provides funding for national and international research partnerships to improve the transfer of skills, knowledge and ideas as a basis for securing commercial and other benefits of research.</p> <p>The different schemes seek to encourage different forms of partnerships between researchers and business, industry, community organisations and/or other publicly funded research agencies. Two of the funding schemes are of specific relevance to the issue of translation of research for economic and social benefit:</p> <ul style="list-style-type: none"> • <i>Linkage Projects</i>: eligible organisations are provided funding to support innovative and collaborative R&D projects with higher education researchers. One of the program aims is to support the initiation and development of strategic research alliances between higher education organisations, industry and end-users to apply advanced knowledge to problems and/or achieve national economic, social or cultural benefits. In 2013 the ARC funded 306 projects to the value of \$101.8m. Over the 2011–12 period 555 projects were funded, to a value of \$168.6m. • <i>Industrial Transformation Research Programme</i>: funding for Research Hubs (to facilitate collaborative research activity between the Australian higher education sector and industry with a focus on strategic outcomes not independently realisable) and Training Centres (to provide innovative Higher Degree by Research (HDR) and postdoctoral training through partnerships between university-based researchers and other research end-users). In 2013–14 the ARC funded 10 Research Hubs with a total funding of \$34.6m. Seven awards were made for Transformation Training Centres, with a total value of \$15.7m. The funding priorities are updated between each funding round but they are currently now aligned with the Government's Industry Growth Centres Initiative (discussed below). <p>In 2014–15 the overall program had a budget of \$326.83 million. The ARC does not publish forward estimates of the funding allocation between schemes (Howard, 2015).</p>	Short term funding for collaboration between universities and other parties

Australia continued.

National Health and Medical Research Council (NHMRC) Development Grants	NHMRC provides Development Grants to researchers undertaking health and medical research at the proof of principle or pre-seed stage to support the commercial development of a product, process, procedure or service that would result in improved health care, disease prevention or provide health cost savings. The budget for this scheme in 2015–16 is \$14.27 million. A 2012 review of 40 grants issued under the scheme found that: 80 per cent had secured a commercial partner, 55 per cent were under possible commercial development, and 6 grant recipients had a product to market or were awaiting regulatory approval.	Provides pre-seed investment
Industry Growth Centres Initiative	<p>The Industry Growth Centre Initiative was established in 2015 with the aim to drive growth, productivity, and competitiveness by concentrating our investment on key growth sectors. Five Industry Growth Centres are being established for sectors of competitive strength for Australia. These are Advanced Manufacturing; Food and Agribusiness; Medical Technologies and Pharmaceuticals; Mining Equipment, Technology and Services; and Oil, Gas and Energy Resources. Each centre is tasked with developing a 10 year strategic plan for the sector and identify opportunities and barriers for growth giving particular consideration to:</p> <ul style="list-style-type: none"> • research collaboration and commercialisation • management and workforce skills • access to global supply chains • the regulatory burden. <p>Some \$225 million is to be invested in this initiative over 4 years. As well as providing operational funds for the centres (up to \$3.5m per year for 4 years, after which they are expected to become self-sustaining), \$78 million is to be provided for a Growth Centres Project Fund. The Initiative will also provide \$74m through the Entrepreneurs' Programme to co-fund commercialisation opportunities in high growth sectors. In both cases, the Government's investment will be no more than 50 per cent.</p>	Intermediaries currently being established
Entrepreneur's Program	<p>The Entrepreneur's Program was launched in 2014 and is administered by the Department of Industry, Innovation and Science. The Program is intended to provide access to expert guidance and connections in order to solve problems and fill knowledge gaps. Financial assistance is not a primary aim of the program however co-funded grants are available to assist in commercialisation and to improve access to research capabilities. Two elements of the program have direct relevance to research translation:</p> <ul style="list-style-type: none"> • Research Connections: eligible businesses are provided with access to facilitators who assist businesses to identify critical and strategic research needs and opportunities; help find expertise, technology, and advice; and find ways to work with the research sector. Following completion of this assessment, businesses may be eligible to apply for a matched funding Research Connections grant to facilitate access to research capabilities (i.e. through engagement of public research organisations to undertake research or the placement of a researcher within the business). Between April and July 2015, 35 grants had been made under the Programme totalling \$1.43m, with a total project value of \$3.77m. • Accelerating Commercialisation: eligible entrepreneurs, researchers and businesses are provided with independent, professional commercialisation advice and access to help them to address key challenges in the commercialisation of novel products, processes and services. The Program also offers grants for Commercialisation Projects. Between April and July 2015, 30 projects had been approved, with a funding commitment of \$15.73m. <p>Participants in the program are expected to either target or participate in the Federal Government identified Industry Growth Sectors. A total of \$484.2 million has been budgeted for 2014–19.</p>	Limited support to business for research collaborations

Brazil		
Brazil's Innovation Law	Brazil's (federal) Innovation Law, passed in 2005, set the legal framework to improve Brazil's capacity to generate and commercialise technology. It provides incentives to increase cooperative R&D between federal government research institutes, the higher education sector and firms. It also regulates the use and management of IP generated from collaborative R&D activities, including requiring a public bidding process for the licensing of technologies.	Overall strategy
First Innovative Firm Program (PRIME)	<p>The Brazilian Innovation Agency (FINEP) launched the PRIME project in 2009 to support start-ups that were focused on innovation, to create favourable financial conditions for emerging companies with high added value.</p> <p>In 2009, FINEP had a budget of R\$230 million (approximately \$A89 million) to allocate. Applicants could be from any industry, have been operational for at least two years and must have a business plan indicative of its growth potential. The program was launched with the objective to help 10,000 innovative companies over four years, creating 10 new jobs for each one directly generated by a new company.</p> <p>FINEP contracted 17 business incubators around the country that had personnel with proven experience, to manage competitive grants. Projects must be completed within 12 months. Successful ventures received R\$120,000 (approximately \$A46,000) to assist in the structuring of its business plan and the development of new services. If the project targets were met, then the entrepreneur received up to an additional R\$120,000 in the form of a loan under the FINEP Juro Zero (Zero Interest) program. This had to be repaid by the end of the following year. In its first year, PRIME had assisted 1,381 start-ups selected through 17 regional public calls, at a total cost of €66.8 million (approximately \$A107 million). This measure is discussed in greater detail in Box 2.21.</p>	Start-ups Grants plus loans
National Program for Innovation Awareness and Mobilisation: Pro-Inova	The goal of Pro-Inova is the creation of an innovation culture by spreading knowledge about the legal framework, establishment of partnerships and access to funding. Pro-Inova partners are representative public institutions and the private sector. Pro-Inova encourages entrepreneurship by diffusing information about the legal tools, facilities and mechanisms available to support initiatives. The main targets are firms and their managers. It supports and strengthens technology transfer units, sectorial technological bodies and state metrology networks. It also promotes innovation events and supports the production of material relating to the management of innovation.	Business, technology transfer units and innovation culture
São Paulo State Research Foundation: NUPLITEC Program	<p>FAPESP, the São Paulo State Research Foundation, is a state-owned agency with administrative and budgetary autonomy. FAPESP supports collaborative projects between universities, research centres and industry. Brazilian companies in sectors such as mining, machinery and equipment, agriculture, and electronics have developed joint R&D contracts with universities and research centres in São Paulo with funds provided by FAPESP and the firms involved. The universities and research centres contribution usually takes the form of infrastructure and knowledge provision.</p> <p>The NUPLITEC (Patents and Technology Licensing Unit) program was established to strengthen the protection of the IP arising from research carried in the São Paulo universities. NUPLITEC also supports inventors seeking firms willing to fund the lodgement of US patents in exchange for licensing rights.</p>	Sector-focused collaboration Patents
Making public sector research laboratories accessible	Brazil's Innovation Law allows government research institutes and the higher education sector to negotiate the use of their laboratory facilities with SMEs. The aim is to facilitate higher levels of R&D among small companies that otherwise would not have access to the equipment, tools, laboratory materials, etc. to develop and implement innovative projects. The Law also allows federal public-sector researchers to establish start-up firms without losing institutional ties and retirement benefits.	SMEs Researchers
Technological Innovation Centres	Brazil's Innovation Law required federal public sector research institutes to create Offices of Technological Innovation which are responsible for the management of the technology generated by researchers. The Brazilian Innovation Agency (FINEP) provided R\$10 million (approximately \$A6.4 million) in 2009 for the creation of 80 Centres in 64 public and 17 private institutions.	Technology transfer units

Canada		
Canada's Research Councils	<p>The Natural Sciences and Engineering Research Council of Canada (NSERC) was created in 1978. Its budget is now \$C1.1 billion dollars (approximately \$A1.15 billion). NSERC promotes and assists research in the natural sciences and engineering, and provides advice to the Minister. Currently the NSERC has partnerships with more than 3000 businesses with 75 per cent being SMEs.</p> <p>In 2009, the NSERC launched the Strategy for Partnerships and Innovation, which has several aims including: facilitating Canadian business investment in R&D; accelerate commercialisation; link university and college expertise to industry; and helping students obtain skills of value to business.</p> <p>The Social Sciences and Humanities Research Council (SSHRC) was created as a federal agency that encourages and facilitates post-secondary research in the humanities and social science fields. The SSHRC supports partnerships between academic staff and graduate students with private, public and not-for-profit organisations. In 2012–13, the SSHRC provided \$C337 million (approximately \$A360 million) in grants, fellowships and scholarships across 30 disciplines.</p> <p>The Canadian Institutes of Health Research (CIHR) was created in 2000 to support Canadian health research. It comprises 13 institutes, which provide leadership and support to health researchers and trainees across Canada. In 2013–14, the CIHR provided \$C718.2 million in research grants, \$C135.6 million in tri-agency programs and \$C67 million (combined total of \$C920.8 or approximately \$A983 million) in training awards.</p>	Strategy for innovation and translation
Engage Grants	<p>Canada's NSERC provides Engage Grants targeted at assisting SMEs to solve company-specific problems through collaboration with university researchers. They also are intended to provide a foundation for larger follow-on collaboration between business and university researchers.</p> <p>Engage Grants are designed to give companies that operate from a Canadian base access to the knowledge, expertise and capabilities available at Canadian universities and colleges. These grants are intended to support short-term R&D projects. A simplified application and decision processes enables researchers to quickly undertake new research collaborations that extend academic expertise to company problems. Engage Grants up to \$C25,000 (approximately \$A26,000) for a period of up to six months support well-defined research projects undertaken by eligible researchers and their industrial partners. This measure is discussed in greater detail in Box 2.2.</p>	Research collaboration between SMEs and universities.
Idea to Innovation	<p>NSERC funds the Idea to Innovation (I2I) Program which aims to accelerate the pre-competitive development of promising technology originating from universities and colleges by making it attractive to potential investors, and promote its transfer to a new or established Canadian company. Funding is provided to the University or college faculty members to carry out R&D. All proposals must include a technology transfer plan that describes how the work will proceed through the next stages in the validation process up to eventual market entry.</p> <p>There are four funding phases that are characterised by the maturity of the technology or the involvement of an early-stage investment entity or industrial partner; Market Assessment, Phase I (to get promising technologies investment-ready), Phase Ib (follow-on funding for high promise projects), Phase IIa and Phase IIb (technical feasibility, market definition, etc.). In all phases except the market assessment, the intellectual property must be protected, or protection should have been applied for. Projects require an early-stage investment entity (Phase IIa) or a company (Phase IIb) to share the costs of the project.</p> <p>Applications for the program are accepted four times per year and subjected to peer-review by external reviewers and the I2I Selection Committee. The contribution is eligible for Canada's Scientific Research and Experimental Development tax incentive. The 2010–11 program budget was \$C5.7 million. The 2011 Review of Federal Support to Research and Development recommended that federal support for the I2I Program be expanded. In the 2011 budget, the Canadian government committed a further \$C12 million (approximately \$A12.8 million) over five years to support the program (Government of Canada, 2011). This measure is discussed in greater detail in Box 2.7.</p>	Technology transfer from universities

Canada continued.

Canada's Foundations	<p>The Canadian Foundation for Innovation (CFI) was created in 1997 to increase Canada's ability to undertake world-class research and to develop technologies. The CFI funds infrastructure that includes state-of-the-art equipment, databases, laboratories, scientific collections, computer hardware and software, communication linkages and the buildings required to conduct innovative research.</p> <p>Since its creation, CFI has provided funding for 8,770 projects at 144 research institutions, totalling over \$C6 billion (approximately \$A6.4 billion). In addition to job creation, CFI-funded infrastructure has contributed to the development of patents, licensing agreements and spinoff companies.</p> <p><i>Genome Canada</i> was created with the intent to foster networks of expertise in Canada, while investing in genomics research, amidst the goal of generating economic and social benefits for Canadians. Over \$C2 billion dollars has been invested in Genome Canada since 2000 with over half of that investment originating from partners. There are six regional Genome centres located across Canada with more than 15,000 full time and highly skilled employees.</p> <p><i>CANARIE</i> designs and manages digital infrastructure and advanced broadband networks that are critical for the distribution of massive amounts of data and information accessed by researchers and students from universities, colleges, research institutes, hospitals, and government laboratories. CANARIE is a not-for-profit organisation founded in 1993 that receives the majority of its funding from the government. In 2015, the government promised continued support of \$C105 million over the period 2015–20.</p>	Strategy for innovation and translation
The National Research Council's Industrial Research Flagship and Industrial Research Assistance Programs	<p>In 2001 Canada's National Research Council (NRC) shifted its research focus toward more applied and commercial-ready industrial research through the creation of three <i>Flagship Programs</i>: The Canadian Wheat Improvement Flagship, The Algal Carbon Conversion Flagship and Printable Electronics Flagship.</p> <p>The NRC's long running <i>Industrial Research Assistance Program</i> (IRAP) provides financial support to Canadian SMEs to undertake technological innovation. To qualify for this support, businesses must first go through an individual consultation with one of the NRC's Industry Technology Advisors, located across Canada, who have extensive business and technical experience. Advisers can suggest collaboration with public sector researchers, supported through other programs. Bother the Flagship Program and IRAP have been adapted, over the years, to meet changing national circumstances.</p>	Industry growth centres SMEs
Networks of Centres of Excellence	<p>The Networks of Centres of Excellence of Canada (NCE) began as a joint collaborative initiative between the various federal research funding bodies in Canada in 1989. The program seeks to bring together experts across multiple disciplines in order to solve major economic, social and health issues that are of critical importance to Canadians. Approximately \$C90 million annually is contributed to the program from government, industry and not-for-profit organisations that provide expertise and financial support. "Since its inception, the NCE has invested about \$C2 billion (approximately \$A2.13 billion) in research, commercialisation and knowledge translation. Those investments have leveraged \$C1.5 billion (approximately \$A1.6 billion) in contributions from industry and other partners" (Government of Canada, 2014). In 2013–14 every \$1 in NCE grants leveraged more than \$2 in partner investments, totalling more than \$C250 million (approximately \$A266.55 million)(Government of Canada, 2015a). A total of \$C641.7 million (approximately \$A684.3 million) in grants has been awarded to 13 active NCE networks (Government of Canada, 2015d).</p>	Similar to Australian CRCs
Centres of Excellence for Commercialisation and Research	<p>Within the NCE Program, the <i>Centres of Excellence for Commercialisation and Research</i> focus on commercialisation, and include not-for-profit corporations, created by a university, college, not-for-profit research organisation, firm or other interested non-government party that aligns the business community with clusters of research expertise. A total of \$C361.9 million (approximately \$A385.9 million) in grants has been awarded to 21 active BL-NCE networks (Government of Canada, 2015c).</p>	Technology transfer

Continued overleaf.

Canada continued.

Business-Led Networks of Centres of Excellence The Business-Led Networks of Centres of Excellence (BL-NCE) are large-scale collaborative networks led by not-for-profit industry syndicates that seek to increase private sector investments in Canadian research. The program was created in 2007 to develop Networks that blend academic expertise with the private sector's drive to respond to real-world challenges and to accelerate the process of translating research into commercial products and services. This measure receives annual funding of \$12 million per year from the federal government, and was made permanent in 2012. The BL-NCEs operate on a matched-funding basis with at least half of each network's research costs paid by partners. Calls for new BL-NCEs are scheduled as funding becomes available, and are tailored to respond to Canada's current research and innovation needs. A total of \$C83.5 million (approximately \$A89 million) in grants has been awarded to 5 active BL-NCE networks (Government of Canada, 2015b).

Chile

Go to Market Chilean Economic Development Agency (CORFO) CORFO's Go to Market initiative, launched in 2011, aims to facilitate the commercialisation and export of the results of applied R&D carried out by enterprises and researchers. The measure supports technology ventures to define their business strategies. It also facilitates connections with potential venture capital firms and collaboration between researchers and business entrepreneurs. Sixteen technology-based companies have been supported to date. Projects from universities, technology centres, and Chilean companies that have viable technologies and global market potential are considered for support, which is not limited to any specific industrial sectors or technology fields. CORFO covers up to 90 per cent of the project costs up to a maximum of approximately \$A112,000. R&D commercialisation

Technology Licensing Offices (TLO) 2.0 The aim of the TLO 2.0 measure is to support Technology Licensing Offices to play their role in the national technology transfer system through knowledge transfer, and business creation from R&D outcomes. This measure aims to increase R&D commercialisation activities and improve the TLO's positioning, by increasing the number of researchers that work on technology development. The first request for proposals in 2011 was for strengthening the offices of technology licensing. The measure targeted national universities and technology centres, supporting twenty-one institutions. As a result, all Chilean TLOs have now developed new policies, procedures and intellectual property regulations, information systems, and increased their networks. Technology transfer units

CORFO will fund up to 70 per cent of the project with the national universities and technology centres funding the remainder of the project. The Directors of the TLOs have created the Technology Managers Network – Chile, as a means to coordinate the professionals from universities and technology centres working on technology transfer-related topics.

Strengthening of human capital for technology transfer This CORFO Program was established in 2011 to address the need for specialists or technology managers that are qualified and capable of leading and training other skilled professionals. This includes specialists in universities that can coach new professionals, and associations of professionals. The measure aims at increasing the number of trained researchers, professionals, and technicians that are involved in the technology transfer within universities and technology centres. Technology transfer skills development

Grant recipients must commission a training organisation that has an international reputation and proven track record. The training organisation provides training courses that enhance technology transfer and R&D commercialisation and cover topics such as technology commercialisation, licensing contracts, R&D portfolio, management, new business and spin-off generation, value proposition and business plans aimed to attract private investment capital, and other programs categories that aim to enhance the technology transfer and R&D results' commercialisation. The annual cost for the Program is around \$A500,000. CORFO covers 80 per cent of the total project cost to a maximum of around \$A10,000. Since 2011, the Program has supported the training of more than 200 people. This measure is discussed in greater detail in Box 2.18.

China		
Law on Promoting the Transformation of Scientific and Technological Achievements and Regulations for Transforming Scientific and Technological Achievements	<p>Issued in 1996 to promote the transformation of scientific and technological achievements into real production, standardise such transformation, hasten scientific and technological progress, and facilitate economic and social development. The law regulates the implementation, safeguards, technological rights and interests, and legal liabilities of transformation of scientific and technological achievements. In 2015, a proposal was made to amend the law to emphasise the important role of Higher Education Institutions in transferring research outputs.</p> <p>The State Council issued the Regulations for Transforming Scientific and Technological Achievements three years after the law was issued. There are three major parts to the regulation, including the encouragement of new technology development and research achievement transfer in research institutes and universities, the guarantee of the autonomy of high-tech enterprises in operation, and the creation of favourable environments for the transformation of high-tech research.</p> <p>The national mid-long-term frameworks for Science and Technology Development, and Education Reform and Development also support the translation and industrialisation of research achievements.</p>	Overall strategy
Science and Technology for Wellbeing Program	<p>The Ministry of Science & Technology (MoST) with the Ministry of Finance launched the Science and Technology for Wellbeing Program in 2013. The program is designed to facilitate the transformation of research achievements in the field of social development and enhance the ability to promote social management innovation and build grass roots-oriented social services through S&T. Its core missions include supporting the transformation and application of advanced research achievements, enhancing practicality and industrialisation, supporting the integration and demonstration of advanced applicable technologies in key areas, and promoting the transformation and application of advanced applicable technologies in the field of public service.</p> <p>This program recognises that collaboration among industries, research institutes, and universities plays an important role in promoting the application of research achievements. Within three years from projects acceptance, the MoST and Ministry of Finance conduct a joint comprehensive evaluation of the effects of the implementation, the use of funds, and the management of the project.</p>	<p>Project-based strategy for innovation and translation</p> <p>Research collaboration</p>
The Torch Program	<p>The Torch Program is designed to develop the strength and potential of Chinese S&T and facilitate the commercialisation of high-tech achievements, the industrialisation of high-tech products, and the internationalisation of high-tech industries. Through this Program, the government creates an environment that helps knowledge and S&T talent enter the market as essential productive factors, and establish a corresponding mechanism. The Program also creates an innovative environment for high-tech enterprises, and supports the uptake of technologies and the integration of firms in supply chains.</p> <p>One of the main goals of the Torch Program is to support enterprises' independent innovation. The Program enables private enterprises to compete for government-funded S&T projects, allowing private technology companies to use stock options to encourage innovation and entrepreneurship. In particular, the Program promotes entrepreneurship and development of S&T enterprises by nurturing business incubators. The Torch Program also contributes to the multi-level capital market, and promotes the construction of an investment and financing system that provides solutions to the financing difficulties encountered by technology companies.</p> <p>Key tasks of the Torch Program include:</p> <ul style="list-style-type: none"> • building high-tech industrial development zones • building technology business incubators • building the national software industrial base • implementing projects aimed at the development and industrialisation of high-tech products with economic benefits and strong potential. <p>Some 2,139 projects were funded by the Torch Program in 2012, including 68 'key' projects. Projects in light mechanical and electrical integration, and new materials and application constituted the majority of projects funded. In 2012, the central government invested ¥220 million (approximately \$A48 million) in the Torch Program, of which ¥117.6 million went to key projects and ¥102.4 million to all other projects.</p>	<p>Establishment of Innovation Clusters</p> <p>Support for start-ups and SMEs</p> <p>Funding for development of technologies and other research achievements</p>

China continued.

Blue Flame Program	<p>Launched in 2008 by the Science & Technology Development Centre of the Ministry of Education, the Blue Flame Program is designed to facilitate targeted collaboration among HEIs and local governments and organisations, using the advantages of HEIs in talent and S&T, to integrate regional economic and industrial characteristics and needs closely. The main objectives of the Blue Flame Program:</p> <ul style="list-style-type: none"> • organise for research staff to communicate with enterprises, understand the technical difficulties they encounter, and promote the translation of universities' research outputs, and solve practical problems experienced by enterprise; • establish a long-term mechanism for collaboration between HEIs and industries, and to introduce a market mechanism to build a policy conducive to transforming research achievements. The Program also plans to build specialised and standardised large-scale technology transfer centres in universities, and foster a number of high quality S&T service teams; and • build a system for collaboration between HEIs and industries. The Program is designed to build a network and platform for collaboration between HEIs and industries, making technology transfer and the mobility of talent and knowledge between HEIs and enterprises operate more smoothly. <p>In 2009, three cities were chosen to pilot the program and within the first year 280 cooperation projects were established. The investment in one of the pilot cities—Zhangzhou—reached nearly ¥2 billion (approximately \$A433 million).</p>	<p>Research collaboration</p> <p>Technology Transfer</p>
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Denmark

GTS—Advanced Technology Group Network—shared infrastructure	<p>The Ministry of Higher Education and Science supports shared research infrastructure through nine Godkendt Teknologisk Service (GTS) Institutes, established as the GTS-Advanced Technology Group network. The GTS institutes are independent not-for-profit organisations whose purpose is to offer knowledge, technology and consultancy, co-operation on technological and market-related innovation, testing, optimisation, quality assurance, certifications and benchmarking.</p>	<p>Innovation services for business</p>
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The GTS Network has two main functions: to develop and maintain the basic technological infrastructure in Denmark and to create technological innovation and development within Danish industry. Companies can buy services from the GTS-institutes or participate in collaboration projects that are co-funded. The Minister of Higher Education and Science approves each institute for a period of 3 years. In 2013, the GTS-Advanced Technology Group had a total turnover of €496.6 million (approximately \$A774 million).

Innovation Fund Denmark (IFD)	<p>The Danish National Advanced Technology Foundation, the Danish Council for Technology and Innovation, and the Danish Council for Strategic Research were amalgamated into a new Foundation—the Innovation Fund Denmark (IFD). In 2015, IFD will invest almost DKK1.6 billion (approximately \$A334 million). The Innovation Fund Denmark is now the major authority responsible for delivering science, technology and innovation programs. Six target research areas have been defined. For each research area, the IFD is creating investment strategies:</p> <p><i>Large Scale Projects:</i> investments in excess of DKK5 million (approximately \$A1.1 million), including projects along the entire value chain from basic research to the market.</p> <p><i>Growth Projects:</i> Investments of up to DKK5 million in SMEs with a viable proposition which have high development potential and which require venture capital to nurture their innovation capacity.</p> <p><i>Talent:</i> investment in industrial PhD/Postdoc positions and offers of support for recent graduates with innovative entrepreneurial propositions. This measure is discussed in greater detail in This measure is discussed in greater detail in Box 3.2.</p>	<p>Strategy for innovation and translation</p>
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Denmark continued.

<p>Innovation Networks</p>	<p>Twenty-two Innovation Networks (sometimes referred to as clusters) offer access to a broad overview on the latest science results and innovation trends within their respective fields of expertise and provide inspiration about new developments in technology and product innovation. The Innovation Networks can also assist researchers in finding new partners for collaboration on science or innovation projects among private companies, other researchers, technological service providers and other partners in Denmark and abroad.</p> <p>Denmark's Innovation Networks are open for all interested companies in Denmark. Some networks charge a membership fee, while participation in others is free of charge. Companies finance their own participation in the Innovation Networks activities. The person-hours contributed by companies are recorded, and are included in total budget of the relevant network.</p> <p>The Ministry of Science, Technology and Innovation finances up to half of the Innovation Network activities. Ministry funding is used for setting up a network secretariat, matchmaking activities, and specific collaboration projects within research, education, and knowledge dissemination. The Networks obtain the other half of the funding from companies or regional funds. Networks are typically allocated between DKK10–20 million (approximately \$A2.1–4.2 million) in government co-financing for a four-year period. They must be able to operate nationwide.</p>	<p>Research collaboration</p>
<p>Innovation Voucher Scheme</p>	<p>The objective of the Innovation Voucher Scheme is to increase the R&D and innovation capabilities of SMEs by fostering collaboration with public research institutions and RTOs, improving knowledge transfer and by strengthening quality and relevance of public R&D. It also aimed to enhance the awareness at knowledge institutions of the need for knowledge and thus secure the quality and societal relevance of public research.</p> <p>The Scheme was established in 2008 and is open to projects within all scientific fields and there are two different forms of vouchers:</p> <ul style="list-style-type: none"> • a <i>basic voucher</i> for a research-based business development project to ensure transfer of knowledge from research to SMEs with a governmental co-funding level of 40 per cent, up to a maximum of €14,000; and • an <i>extended voucher</i>, with state co-funding level of 25 per cent up to a maximum of €67,000. SMEs have to provide 50 per cent of the total funding, and the research institution at least 25 per cent. <p>A total of DKK 35 million (approximately \$A7.3 million) is allocated annually and distributed from Innovation Fund Denmark. This measure is discussed in greater detail in Box 2.4.</p>	<p>Vouchers to access public sector research institutions</p>
<p>The National Network for Technology Transfer</p>	<p>The National Network for Technology Transfer manages <i>techtrans.dk</i>: an open forum for public research institutions, private business and others looking for information about the innovative collaboration between researchers and companies. The members of the Network are the technology transfer offices at public research institutions, whose role is to ensure that the institution secures attractive returns in the long term from the commercialisation of its research outcomes and intellectual property.</p> <p>The aim of the network is to provide a national forum where public researchers and staff from companies involved in commercialisation can develop competences, build knowledge and methods, share experiences and deal with intellectual property rights. Through courses, seminars and conferences, the network seeks to raise the collective awareness of, and insight into the process of technology transfer. Techtrans.dk includes the <i>Patent Exchange</i>, a database of published patents and patent applications from public research institutions in Denmark. This measure is discussed in greater detail in Box 2.14.</p>	<p>Public sector patent database</p>

Denmark continued.

Strategic Platforms for Innovation and Research (SPIR)	<p>SPIR funds initiatives which seek to strengthen the link between strategic research and innovation, dissemination and possibilities for fast application of new knowledge in connection with innovation in the private and public sectors. SPIR is now managed by Innovation Fund Denmark. The program aims to establish a Danish model for strengthening the links between research and innovation and to create a partnering model in which private sector enterprises are more extensively involved in both the planning and performance of research and innovation.</p> <p>The program publishes annual requests for proposals in two phases: a pre-qualification phase and a final phase. In the first phase, the focus is on strategy, organisation and how innovation and research are linked in the platform. The pre-qualified applicants will then have the opportunity to expand on and continue working on the application and bring in additional partners.</p> <p>The platform may comprise partners (enterprises and institutions) and participants (individuals engaged in research, development and innovation) from both public sector institutions and the private sector (from Denmark and abroad). SPIR platforms must have an organisational model designed to promote interaction between the research and innovation actors. In 2013, DKK64 million (approximately \$A13.4 million) was provided from the Danish Council for Strategic Research and The Danish Council for Technology and Innovation to fund the SPIR Program.</p>	Research collaboration
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Finland

Tekes	<p>Tekes, the Finnish Funding Agency for Innovation has the primary responsibility for promoting innovation, including commercialisation of public sector research and has been supporting R&D involving businesses and research groups since 1983. Tekes' mission is to promote the development of industry and services by means of technology, innovation and growth funding. Tekes programs support the national R&D efforts of enterprises, research institutions and universities into selected technologies and priority themes. Tekes programs are targeted or mission-oriented schemes.</p> <p>There are currently 16 Tekes programs, the size and focus of which vary considerably. The duration of Tekes programs is usually between 4–6 years with budgets ranging from a few million to over €200m. Tekes typically funds approximately 50 per cent of program budgets. In 2014, Tekes funded 2,750 projects valued at €550 million (approximately \$A860 million). Some 40 per cent of these funds were allocated to companies and public organisations, 30 per cent to universities and 30 per cent loans to start-up companies. The Tekes programs received €513.3 million (approximately \$A801 million) in the 2014 state budget (Official Statistics of Finland, 2014). This measure is discussed in greater detail in Box 3.2.</p>	Strategy for innovation and translation
Tekes: Funding for young innovative companies	<p>Tekes offers funding for young innovative companies for the comprehensive development of their business activities. The aim is to substantially accelerate the global growth of the most promising small companies. Funding is provided to companies that have been operating for several years and have proven their business concepts so that they already have customers. The maximum amount of Tekes funding for young innovative companies is €1.25 million, of which maximum of €500,000 may be funded as a grant (Phase 1 and 2) and €750,000 as a loan (Phase 3). Tekes may fund up to 75 per cent of the eligible project costs. The total budget for the Program was just over €19 million (approximately \$A30 million) in 2011.</p> <p>This funding is for business development. Companies that have progressed during the first phase in accordance with the targets are allowed to present their company and idea to an evaluation panel convened by Tekes.</p> <p>Since 2008, 260 start-ups have been selected for the Program, and 75 have passed successfully through all three funding phases and attained 'Champion' status. Tekes continues to evaluate the impact of projects after their completion. This measure is discussed in greater detail in Box 2.3.</p>	Business development, particularly SMEs

Finland continued.

<p>Tekes: New Knowledge and Business from Research Ideas</p>	<p>The New Knowledge and Business from Research Ideas initiative aims to support research projects, where scientists take the development of an idea further while preparing for the commercialisation of the idea into new business. The research projects are intended to create new high-level competences in areas expected to be important for businesses in the future. Projects produce knowledge and competence that are significant for utilising a research idea. The research part of the project focuses on issues that play a key role in the commercialisation of the concept and the project must examine several alternative commercialisation possibilities.</p> <p>No business participation is required in this project type. However, companies may lend their expertise to the work of the project's steering group but do not have a right of first refusal to the project results. Eligible participants include academics, large-scale industry bodies and SMEs. Projects can receive funding of up to €350,000 (approximately \$A546,000) over 2–10 years. This measure is discussed in greater detail in Box 2.6.</p>	<p>Pre-commercialisation development</p>
<p>Tekes: Public Research Networked with Companies Program</p>	<p>This Program aims to achieve competence and results that can be used as a springboard for the companies' own research and development projects. These programs are targeted at financial and expert service areas. Businesses and public research units develop new know-how, build networks and have an impact on the development of their field.</p> <p>Companies and research organisations can create a joint R&D project together, where the starting point is the research needs of the companies. Interest expressed by businesses in the project is a precondition for being granted Tekes research funding. Ensuring the commitment of companies that will potentially utilise the results and will actively participate in the work of the project's steering group is vital. Tekes typically funds 60 per cent of the project costs with companies contributing the remaining funds. Applications can be submitted at any time. The partnering company may not receive an immediate return on their money, but they will have the right of first refusal to using the results.</p>	<p>Research collaboration</p>
<p>Tekes: Strategic Centres for Science, Technology and Innovation (SHOK)</p>	<p>Six Strategic Centres for Science, Technology and Innovation (SHOK) were established between 2007 and 2009 with the key objective of promoting closer cooperation between business and research. The Centres focus on producing globally new information and its efficient utilisation. Their activities aim at increasing the volume of international cooperation and funding.</p> <p>The Centres take the form of public-private partnerships aimed at speeding up innovation processes, renewing industry clusters and creating radical innovations. Companies and research units work in close cooperation to carry out research that has been jointly defined in the strategic research agenda of each Centre. The research is targeted to meet the needs of Finnish industry and society within a 5–10 year timeframe.</p> <p>SHOK shareholders make the decisions on research programs, their implementation and sources of funding. Key public funding providers are Tekes and the Academy of Finland. Tekes funds the SHOK research programs and projects initiated by companies. On average about 40 per cent of research conducted by the SHOKs is co-funded by companies, 50 per cent by Tekes and 10 per cent by the Academy of Finland. In 2014, Tekes funding for the Centres was €88 million (approximately \$A137 million). Between 2008 and 2013, Tekes provided a total of €450 million (approximately \$A703 million) for the SHOK Program.</p>	<p>Similar to Australian CRCs</p>
<p>Tekes: Strategic Research Openings</p>	<p>Strategic Research Openings are projects designed to create new high-level competences in areas expected to be important for businesses in the future. Strategic research projects seek to achieve breakthroughs, creating new skills and aiming at the creation of significant new areas of growth in Finland. No business participation is required, but companies may lend their expertise. Participating companies do not have a first right of refusal in relation to project results.</p>	

Germany		
Central Innovation Programs for SMEs (ZIM)	<p>The ZIM Program was created in 2008 from the combination of three previous measures, with the aim of increasing transparency and reducing administrative costs for SMEs. The ZIM Program is designed to foster market-driven technology-based R&D work within German SMEs to enhance companies' capacity to innovate and to strengthen their long-term competitiveness. Under ZIM, companies and the research institutes they work with can be awarded grants for ambitious R&D projects. Funding is not restricted to any particular field of technology or to specific fields of application. The ZIM Program has three elements:</p> <p><i>ZIM-SOLO</i>: provides funding for individual companies doing their own in-house R&D. Funding is provided for the costs of the projects and may also be provided for support and consulting on innovation. ZIM-SOLO had a total budget of €147 million in 2012.</p> <p><i>ZIM-KOOP</i>: provides funding for R&D carried out jointly by two or more companies, or by one company and one or more research institutes. Funding may be provided for R&D cooperation projects between companies, or between companies and research institutes, for the development of new products and processes. These projects should be conducted so that all partners make innovative contributions. Funding may also be provided for support and consulting on innovation. The program had a total budget of €325 million in 2012 (approximately \$A516 million).</p> <p><i>ZIM-KOOP networks</i>: provides funding for the management of innovative networks that comprise at least six SMEs which jointly develop an innovation. Funding can be provided to cover both management and R&D projects initiated by the network. The program had a total budget of €20 million in 2012.</p> <p>Since the start of the ZIM program in 2008, 19,265 projects have been approved at a total cost of €2.5 billion. Up to 69,500 jobs have been secured or created; generating income of €7.4 billion. In 2015, ZIM's budget is scheduled to grow to €543 million (approximately \$A872 million). This measure is discussed in greater detail in Box 2.1.</p>	Research collaboration with SMEs
Cluster Programs	<p>The <i>Leading-Edge Cluster Program</i> was launched in 2007 to support high-performance clusters formed by business and science in strategic partnerships with the objective of boosting Germany's innovative strengths and economic success. There have been three funding rounds (in 2008, 2011 and 2014). In each round, up to €200 million (approximately \$A516 million) has been made available to five Leading-Edge Clusters over periods of up to five years, with matching financing by businesses and private investors. Total funding has been €1.2 billion (approximately \$A1.87 billion) since 2007 (50 per cent private funds and 50 per cent from Federal Ministry of Education and Research). The Fraunhofer Institutes are key players in these clusters.</p> <p>The state government of Baden-Württemberg systematically supports the further development of clusters. A strong cluster landscape has progressively developed in Baden-Württemberg covering more than twenty-five fields. A large number of companies, research institutes and universities are integrated in regional cluster-initiatives and networks at federal and state level. This measure is discussed in greater detail in Box 2.15.</p>	Clusters
ERP Innovation Program	<p>The <i>ERP Innovation Program</i> is aimed at SMEs and self-employed people working in the professional-services sector. The focus is on cooperation with research institutes and the objective is to promote innovation and to quickly bring new practical applications to market. The budget was €1,309 million (approximately \$A2 billion) in 2011, funding 695 projects.</p> <p>There are two parts of the program which companies can apply. Part 1 provides funding for close-to-market research and for the development of new products, processes, and services in Germany. Part 2 provides support for the launch of new products, processes and services into markets in Germany, and is available to SMEs only.</p> <p>Part 1 and Part 2 can be used independently from each other, but it is also possible to combine the two. The program offers SMEs a loan which typically consists of two tranches: a classical bank loan (offered at below market interest rates and requiring collateral), and a subordinate loan (50–60 per cent of the total loan, depending on the size of the total loan). These loans are provided from the ERP Special Fund and are offered at low interest rates. Loans can cover up to 100 per cent of eligible costs, up to a maximum of €5 million per project. Projects that are linked to the energy reforms are eligible for loans of up to €25 million per project. The cap for individual companies is €50 million per calendar year.</p>	SME cooperation with research institutes

Germany continued.

<p>Protection of Ideas for Commercial Use (SIGNO)</p>	<p>SIGNO supports SMEs, universities and individual inventors in using IP rights to protect and commercially exploit their innovative ideas. The main objectives of this measure are to overcome information and financial barriers to the use of IPRs by universities, SMEs and individual inventors and to raise awareness about the relevance of IP rights for commercialising innovations. SIGNO is Germany's largest network for inventors and patents. It comprises three sub-programs:</p> <ul style="list-style-type: none"> • SIGNO Universities facilitates the commercialisation of university IP to industry by assisting the process of making patent-protected scientific and technical information available to businesses that might take-up a licence. • SIGNO Enterprises operates an SME Patent Initiative that offers grants up to €8,000 to SMEs that want to use IP rights for the first time. • SIGNO Inventors provides inventors with key information on how to use IP rights. An inventors' competition targets young inventors, with awards are given to the most innovative and creative ideas. <p>The SIGNO budget in 2012 was €16.5 million (approximately \$A25.8 million). This measure is discussed in greater detail in Box 2.19.</p>	<p>SME IP</p>
<p>Start-ups from Science (EXIST)</p>	<p>The <i>Start-ups from Science (EXIST)</i> initiative was created in 1998 and is a support program of the Federal Ministry of Economics and Energy (BMWi). It aims to improve the entrepreneurial environment at universities and research institutes and to increase the numbers of technology and knowledge based company start-ups, which are seen as an important mechanism for the knowledge transfer from science to industry. EXIST is part of Germany's High-Technology Strategy and is co-financed by the European Social Fund. The EXIST budget in 2012 was €32.1 million (approximately \$A51 million).</p> <p>EXIST-Gründerhochschule (Culture of Entrepreneurship) supports universities to build an entrepreneurial and start-up oriented environment at these institutions. In the first conceptual phase, the universities receive grants of up to €70,000 over a six month period. The second project phase can last up to 5 years and funding can be up to €1 million. The program has covered four different phases of university start-up initiatives, with slight variations in assistance mechanisms. EXIST Business Start-Up grants support the preparation of innovative business start-up projects at universities and research establishments. EXIST Transfer of Research grants promote especially sophisticated technology-based business start-up projects in the pre-start-up and the start-up phase.</p>	<p>Start-ups</p>
<p>Validation of the technological and social innovative potential of scientific research (VIP+)</p>	<p>The objective of the <i>VIP+</i> Program is to encourage significant innovation by strengthening the bridge between the research and the exploitation and application of research findings. The Program creates the conditions for the further development of research results into innovative products, processes or services. It began in 2015 and builds on the prior pilot program <i>VIP</i>. The drive for the program came from the Government's High-Tech Strategy 2020 and recognises that significant innovation often arises at the interface of different disciplines.</p> <p>The Program is aimed at universities and research institutions that are financed in whole or in part by the federal government. Applications may be submitted continuously, with an expert committee meeting regularly to assess the quality and eligibility of applications. Researchers can submit an application independently or as part of an integrated research project with other institutions. Projects must build on existing research results, and there must be evidence of the fundamentals of validation, such as a proof of concept. Projects are eligible for up to €500,000 (approximately \$A781,000) per year for a maximum of three years to support further R&D. Funding is provided from the Federal Ministry of Education and Research (BMBF) and is administered through VDI/VDE Innovation + Technik GmbH.</p> <p>In the opening funding round, 132 projects were approved: 25 in the life sciences, 56 in engineering, 41 in the natural sciences, and 10 in services research. The total BMBF budget for funding projects regarding knowledge and technology transfer under the High-Tech Strategy was €10 million (approximately \$A15.6 million) in 2011.</p>	<p>Inter-disciplinary research commercialisation</p>

Israel		
Kamin	<p>The <i>Kamin</i> Program is designed to foster applied research in research institutions in Israel. The Program provides continued support for basic research that is technologically innovative and has demonstrable commercial potential. The primary aim being to bring it to the stage where business entities in Israel are able to make a decision on a commercialisation agreement with the institution. The Kamin Program serves as another bridge between basic research, and applied research with potential that can be recognised by business. The Program allows a research group to continue a study which began as basic research and is no longer eligible for support from competitive research grants supporting basic research (such as the National Science Foundation). The intention is to bring the research to a stage where industrial entities may show an interest in investment. Partnering companies or potential investors are not required to participate with the researcher in this Program (by comparison with Nuphar).</p> <p>Kamin is open to all fields of science and technology which have the potential implementation by Israeli industry. Funding is provided from The Office of the Chief Scientist and complementary funding is provided from the academic institution or through its technology transfer company.</p> <p>Grants are determined according to the duration of the project:</p> <ul style="list-style-type: none"> • Specific research for up to 12 months (90 per cent of costs, maximum of NIS 360,000—approximately \$A129,000) • Specific research for up to 24 months (85 per cent of costs, maximum of NIS 680,000) • Research Extension Period for up to 12 additional months (66 per cent of costs regardless of the length of the extension period, maximum of NIS 264,000). <p>The Program allows for the transfer of the knowledge to industry (including to start-up company to be established on the basis of this knowledge) for further development and commercialisation in the global markets. Companies receiving these grants are exempt from payment of royalties. However, they are required to keep the knowledge in Israel in accordance with Israel's R&D Law. This measure is discussed in greater detail in Box 2.10.</p>	Pre-commercialisation support for researchers without company engagement
Magnetron	<p>Israel's <i>Magnetron</i> Program aims to encourage technology transfer from research institutions to industrial corporations through collaboration. Specifically, it encourages activities that would not otherwise occur, to maximize commercialisation of the breadth and depth of the technological capability in academic research institutions for the benefit of Israeli industry.</p> <p>Funding is provided for joint R&D projects, and requires that both the research institute and the industry partner take part in the project. Upon project completion, the industry partner is expected to commercialise the technology developed in the project. Eligible projects receive a grant of up to 66 per cent of the approved budget for a period of 12 to 24 months. The total project budget for both organisations can be up to NIS 3.4 million (approximately \$A1.2 million). This measure is discussed in greater detail in Box 2.13.</p>	Technology transfer
Meimad	<p>The Ministry of Finance, Ministry of Defense and Ministry of Trade and Industry work together to promote the research and development of dual-use technologies that can contribute to the security of the state and have economic potential in international commercial markets. To achieve this, a joint <i>Meimad Fund</i> has been set up to support R&D activities that would not attract support through other measures.</p> <p>Funding can be sought an Israeli SME (defined as up to \$US50 million sales per year) or by a research institute. The duration of projects is up to 30 months, with a maximum budget of NIS 5 million (approximately \$A1.8 million). Projects are eligible to receive grants for 50 to 66 per cent of the project budget when performed by an industrial company, and 50 to 90 per cent of the budget when the project is undertaken by a research institute.</p>	Commercialisation of dual-use technologies

Israel continued.

<p>Nuphar</p>	<p>The <i>Nuphar</i> Program was designed to foster applied research in research institutions in Israel, which is a continuation of the previous basic research and is part of the Magnet programs of the Office of the Chief Scientist. The Program serves to bridge basic research and applied research, allowing research groups to continue their study which began as basic research, and is no longer eligible for support from competitive research funds intended to promote basic research (such as the National Science Foundation). Rather the measure brings research outcomes to a stage where knowledge is transferred to industry for further development of the technology, investment and promotion of a product.</p> <p>The Program enables the broad and deep engagement of scientific competence in the academic research institutions for the benefit of the industry. The Program is open to biotechnology, nanotechnology, medical devices, water technology, and energy proposals. The research outcome is for industrial application in Israel, and should be of high added value to the Israeli industry.</p> <p>An industrial company must fund at least 10 per cent of the project (unlike the Kamin Program). In return, it has “right of first observation” of the findings of the study and the “right of first negotiations” for a pre-defined period. The business providing the supplementary funding has the ability to guide the research towards industrial applications. The research period is up to 12 months and approved projects will receive a grant at a rate up to 90 per cent of the approved budget. The maximum amount of the project budget is NIS 500,000. For multidisciplinary research involving research groups from various faculties, the maximum amount of the project budget is NIS 660,000. Each research group in the project provides up to NIS 330,000 (approximately \$A118,000).</p>	<p>Pre-commercialisation support with company engagement</p>
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Japan

<p>Public-private partnership policy</p>	<p>Japan’s first Science and Technology Basic Plan was developed in 1996. The Plan provided the basis for the development of new systems to support R&D in Japan, including arrangements for research cooperation between the public and private sectors. Following passage of the Act on the Promotion of Technology Transfer from Universities to Private Business Operators (the TLO Act) in 1998, technology transfer offices were established with government financial support.</p> <p>The “Concerning Revitalization of Industry and Innovation in Industrial Activities” measure, which included provisions similar to the US Bayh-Dole Act, was established in 1999. This permitted universities and public research institutes to license patents arising from publicly-funded R&D. Universities established offices to manage the intellectual property from their research. Between 2005 and 2013 the number of Japanese university patents has increased 10 times for domestic patents, and 7 times for overseas patents. In 2013, university income from licensing and transferring patents was ¥2.2 billion.</p>	<p>Strategy for innovation and translation</p>
<p>Adaptable and Seamless Technology Transfer Program (A-STEP)</p>	<p>Japan’s Science and Technology Agency (JST) <i>A-STEP</i> supports industry-academia collaborative R&D across a range of phases to develop commercial applications of research output generated by basic research in Japanese universities. A-STEP provides ten types of support for collaborative university-industry R&D across different phases of technology development. The JST determines the appropriate A-STEP funding for each phase.</p> <p>Projects from all fields of natural science can receive funding. The feasibility stage includes the investigation of technology transfer potential; validation of potential as a technology seed that will meet the needs of companies; and validation of potential to become the technology seed for a university-launched start-up company. The full-scale R&D stage includes R&D in preparation for the establishment of a university start-up venture, R&D during the practical verification and testing phase, through to joint R&D by an industry-academic partnership. The funding provides incentives for researchers of universities to transfer their research results to industry. A-STEPs budget in 2012–13 was ¥14.7 billion (approximately \$A169.2 million), but this was reduced to ¥8.1 billion (approximately \$A93.2 million) in 2014–15. This measure is discussed in greater detail in Box 2.12.</p>	<p>Research collaboration to establish start-ups</p>

Japan continued.

National Institute of Advanced Industrial Science and Technology (AIST)	<p>AIST was established in 2001 by aggregating 15 research institutes within MITI. The aim of AIST is to promote economic and industrial development, and to secure a stable supply of resources and energy. It seeks to achieve this aim by pursuing mining and manufacturing industry development, conducting geological surveys, setting measurement standards, offering technological support, disseminating research results, and developing human resources that can help strengthen technology management capabilities. AIST focuses on the creation and practical implementation of technologies, and on bridging innovative technological concepts and commercialisation.</p> <p>In 2013, AIST's budget was ¥94 billion (approximately \$A1.08 billion). METI contributes ¥70.5 billion (75 per cent), and NEDO provides ¥13.2 billion (14 per cent) for projects conducted by AIST. AIST now has 22 research institutes and 20 research centers in seven technology fields. AIST staff pursue research that integrates all stages from basic to production research. AIST provides an open innovation hub for government-industry-academia collaboration, allowing its researchers to conduct free R&D for industry.</p>	Public sector research institutes
National R&D projects by New Energy and Industrial Technology Development Organisation (NEDO)	<p>NEDO is one of Japan's three main R&D funding organisations. NEDO provides funds to business enterprises for projects that are undertaken in partnership with universities and/or AIST. These projects explore future technology ideas as well as mid- to long-term industrial technology development. NEDO is funded by the Ministry for Economy, Trade and Industry (METI) with a 2015 budget of ¥131.9 billion (approximately \$A1.4 billion).</p> <p>NEDO currently funds and manages around 64 national R&D projects to support the development of important technologies that are high risk and would not be developed by private companies on their own. The projects run for 5–10 years. NEDO supports the employment of new graduates from universities or graduate schools, and also mid-career engineers from companies. Research funded by NEDO may result in academic papers and patents. Research results are expected to be commercialised by companies participating in the R&D projects. NEDO has a 30 per cent of target rate for commercialisation of R&D. The 2015 budget for the 64 national projects is ¥121.5 billion (approximately \$A1.4 billion).</p>	Research collaboration to achieve commercialisation
START Program	<p>The <i>START</i> Program was initiated by MEXT in 2012 and transferred to JST in 2015. The Program aims to develop business/IP strategy and commercialise technology 'seeds' in universities that are risky but have great potential. <i>START</i> works by combining government funding and private sector commercialisation knowledge at the time that a start-up is founded. A researcher and an entrepreneur with a team of experts jointly formulate an R&D and business development plan. Milestones are determined on the basis of market needs. Some 56 entrepreneur in 13 research institutions and 58 projects have been approved. The Program consists of two sub-programs:</p> <p>The <i>Project promotor support</i> sub-program assists entrepreneurs who have commercialisation know-how and want to create R&D-based businesses. The Program funds the entrepreneurs for activities to discover the promising technological 'seeds', and to provide hands-on support using their networks and know-how.</p> <p>The <i>Project support</i> sub-program calls for applications based on promising technological seeds from universities or public research institutes. The average annual project subsidy in 2014 was about ¥30 million.</p>	Technology development
Korea		
The 5th Basic Plan for Technology Transfer and Commercialisation Promotion	<p>This plan is being implemented by the Ministry of Technology, Industry and Energy. Key contents of the plan include: Targets and strategies of technology transfer & commercialisation, matters related to budgets for the implementation of the plans, activities and infrastructure to promote technology transfer, ways to strengthen technical evaluation, and financial support to stimulate technology commercialisation.</p> <p>Earlier plans have been considered successful; the number of technology transfers had doubled and royalty income in 2012 increased 1.6 times compared to those of 2007. The Plan sets targets for increases in the technology transfer rate and research productivity of public research institutes, and outlines strategies to achieve them, such as to stabilise the operation of the technology trade market, enhance the technology marketing capabilities of public research institutes, supply technologies with high potential for commercialisation, and foster an environment favourable to the growth of companies at the early commercialisation phase.</p>	Overall Strategy

<i>Korea continued.</i>		
Act on Promotion of Technology Transfer and Commercialisation	The purpose of this Act is to promote technology that was developed by public sector to be transferred to private sector that leads to commercialisation. The Act also aims to facilitate active transactions and commercialisation of technology so that it can contribute to economic development of the nation based on higher technological competitiveness of the overall industries.	Technology Transfer and Commercialisation of Research
Korean Industrial Research Council Public Research Institutes' Technology Commercialisation Measures	The project aims to increase the internal capability of Technology Liaison Offices (TLOs) and spread research outcomes by providing effective programs on IP management and technology transfer/commercialisation. It aims to improve the IP management capabilities of government-funded research institutes' TLOs. The project is divided into three programs listed below with specific objectives: 1. To resolve common issues faced by government-funded research institutes in an aim to improve quality of the support program and achieve work efficiency. 2. To provide dedicated support to late starter TLOs. 3. To provide customised support to strengthen the capabilities of individual government-funded research institutes with weak IP management capabilities.	
Technology Transfer Promotion Act	This law took effect in 2000 with objectives to promote technology transfer to private sector and commercialisation of technologies developed at public research institutes, and to promote smooth transactions, transfer and commercialisation of technologies developed in the private sector. The law requires public research institutes (PRIs) to set up separate Technology Licensing Offices (TLOs) to promote technology transfer from the PRIs to SMEs. In 2014 there were a total of 172 TLOs (121 in universities and 51 in Government Research Institutes (GRIs) and other not-for-profit research institutes). The government selects well-performing TLOs each year and provides financial support. The government also encourages PRIs and universities to set up technology holding companies (THCs) dedicated to facilitating the commercialisation of research results from universities (OECD, 2014b). In 2009 the Korean Institute for Advancement of Technology was created to be a manager of technology transfer and commercialisation measures (British Council, 2015).	Technology Licensing Offices
Technology Licensing Office (TLO) system for universities and GRIs	The program aims to promote and facilitate university and GRI based technology transfer and commercialisation. Government support leading to TLOs in universities and GRIs continued for five years from 2006. Twenty-two universities and 13 GRIs were financed each year with total amount of KRW3.4 billion (approximately \$A4.16 billion). Since 2006, the number of technology transfers from universities and GRIS to private companies has increased to nearly 200 per cent and the royalty income from the transfer has also increased by about 340 per cent. Additionally, increasing the proportion of technology transfer produced by the GRIs and universities among the total R&D investment into them from roughly 5 per cent in 2004 to roughly 13 per cent in 2009; the royalty income from transfers increased to €79 million (approximately \$A123.4 million) in 2009 from €32.4 million (approximately \$A50.6 million) in 2004.	Technology Licensing Offices
New Technology Purchasing Assurance Program	Established in 1996, the New Technology Purchasing Assurance Program for innovation-oriented SMEs. Under this program, if the technological products of SMEs are certified as "goods for purchasing assurance", the Small and Medium Business Agency can recommend that all public institutions including central and local government, and state-owned or funded companies and institutions, procure these products with higher priority (OECD, 2014b). The pre-commercial procurement is aimed at purchasing R&D, design, prototyping and testing services for products or services that do not yet exist on the market.	Innovation-oriented public procurement

Singapore		
National Research Foundation (NRF): Corporate Laboratory@University	Corporate Laboratory@University is a one-off grant provided by the NRF to bring about close collaboration between private sector players and public-funded researchers. The grant enables corporations set up their laboratories in university premises. NRF supports these laboratories with manpower, equipment, and other operating expenses in collaboration with the university. The industry partner matches the grant funding provided by NRF. This measure was launched in 2008 and has led to the creation of five on-campus corporate laboratories. A total of over SGD100 million (approximately \$A99.3 million) has been invested by NRF, matched by the industry partners.	Corporate laboratories on university premises
Early Stage Venture Fund (ESVF)	The NRF's Early Stage Venture Fund (ESVF) aims to increase the availability of private sector capital, and reduce the risk profile of investments. NRF invests SGD10–15 million on a 1:1 matching basis with other private sector incubators. To provide incentives to investors, NRF offers an attractive profit distribution scheme: NRF only takes profits up to five per cent rate of return. Any surplus profits are distributed to the other investors. However in the event that these profits are not achieved, the NRF offers a first-loss protection to reduce risk for fellow investors. The ESVF was launched in 2008 with an initial budget of SGD50 million (approximately \$A49.7 million) to support five venture capital firms, and was extended in 2014 with another SGD48 million supporting six more venture funds. This measure is discussed in greater detail in Box 2.24.	Similar to Australia's IIF Program
Growing Enterprises with Technology Upgrade (GET-Up)	<p>GET-Up is an Agency for Science, Technology and Research (A*STAR) initiative providing a range of technology assistance to SMEs through three schemes: <i>Technology for Enterprise Capability Upgrading</i>—can include the secondment of research scientists and engineers to companies to develop in-house R&D expertise for projects managed by companies. The grant supports 70 per cent of the secondment costs for up to two years. GET-Up was launched in 2003 and has assisted more than 400 companies.</p> <p><i>Operational and Technology Road mapping:</i> support is given by assisting the development of a technology roadmap which is aligned to a business strategy. Five sessions with senior management can take place, covering markets, products/services, technologies needed, available resources and implementation plan.</p> <p><i>Technical Advisor:</i> appointment of senior researchers as technical advisors to companies to provide in-depth technical advice; and to facilitate collaborations between companies and research institutes.</p>	Secondment of researchers to SMEs
National Innovation Challenge (NIC)	The NIC Program was launched in 2011 with a budget of SGD 1 billion (approximately \$A994.5 million). Approximately half of the budget has been allocated to three executive committees, each of which leads a project—The Energy NIC, The Land and Liveability NIC and The National Cybersecurity R&D Program. The NIC serves as a platform that involves Singapore's research capabilities in diverse areas by involving multiple government agencies and researchers in a whole-of-Government approach. The NIC was set up by NRF to utilise multidisciplinary thinking as a means to find solutions to complex national problems.	Research collaboration on issues of national interest (similar to Australian CRCs)
NRF Fellowships	NRF Fellowships were launched in 2007 to attract top international research talent. The Fellowships provide grant support to early-stage (post-doctoral) researchers from any nationality, to carry out independent research in Singapore. The Fellowships can be taken up at universities and A*STAR's research institutions. Each Fellow is provided with a research grant capped at SGD3 million (approximately \$A2.98 million) for five years to carry out independent research in information and communications technologies and interactive digital media; engineering; life sciences; and natural/physical sciences. The Fellowships Program has a long-term horizon. As the research is independently-led, it may not always have direct applications in industry.	Research fellowships

The United Kingdom

Catapult Program	<p>The UK Catapult Program was launched in 2010 with the objective of creating intermediate technology organisations to act as an interface between the business and university sectors. Total support in 2012–13 for seven Catapult Centres was £121.3 million (approximately \$A257.6 million). There are currently nine Catapult Centres. The Program is administered through Innovate UK and has evolved through a series of stages, each of which has involved the creation of a new Catapult Centre. The Catapult funding model is that one third of Centre funding comes from the public sector, one third from the private sector and one third from the university sector. The Catapult Centres are located across the Technology Readiness Levels 3 to 7 where, it is perceived, is a major gap in the UK innovation system. A recent review has been favourable. This measure is discussed in greater detail in Box 2.22.</p>	Intermediaries
Collaborative Grant for R&D program (CR&D)	<p>The Innovate UK program of grants for collaborative research and development (CR&D) was introduced in 2004. It brings together partners from Higher Education and businesses through collaborative bids for funding. These may be co-funded by the Research Councils, other funding agencies and government departments. Annual funding for the scheme was around £173 million (approximately \$A367.4 million) in 2012–13. Outputs from the partnerships include clarification of technical issues, feasibility of ideas, technical knowledge, prototypes and products/services. CR&D grants have directly generated substantial numbers of new jobs, with additional jobs arising from the wider supply chain and linkages.</p>	
Innovation and Growth Vouchers	<p>UK Innovation Vouchers help to overcome barriers to engagement between SMEs and knowledge providers in the public and private science base. They enable SMEs to approach knowledge providers with a subsidy equal to the value of the voucher. Additionally, the provision of the voucher provides a financial incentive for public knowledge providers to engage in collaborative activities with SMEs. This can address the tendency for higher education institutions to partner only with larger firms, or to have limited industry engagement. Support for university research and for university-businesses collaboration through Innovation Vouchers was £3.5 million in 2012–13.</p>	Collaboration with SMEs using vouchers
	<p>The <i>Innovate UK Innovation Vouchers Scheme</i>: Launched in 2012, the vouchers are awarded to SMEs to enable them to place contracts with higher education institutions. Every three months the scheme awards vouchers worth up to £5,000 to pay for external expert advice. This advice is to promote business growth linked to a novel idea, or the use of design or intellectual property, or the use of specialist equipment or facilities. Eligible businesses must employ less than 250 people.</p>	
	<p><i>UK Growth Vouchers Research Program</i>: Launched in January 2014, the Program is designed to enable SMEs to obtain expert advice in a number of areas. It began as a joint Program between the Department of Business Innovation and Skills and the Behavioural Insights Team of the Cabinet Office. The scheme was designed as a business-to-business scheme and did not specifically target transactions linking SMEs to the science base. Rather, it was designed to answer the question “Do businesses that use external advice perform better than those that do not?” The scheme was delivered on a regional basis. The Program aimed to attract 20,000 businesses. Three-quarters of the business applicants were given a voucher for up to £2,000 to cover half the costs of the strategic advice in their chosen area. Firms can pay more if they choose but the maximum amount claimable is £2,000. The long term impact of the Growth Vouchers Program is to be analysed using a randomised controlled trial and will last for five years from the date when the voucher applications closed.</p>	
Higher Education Innovation Fund (HEIF)	<p>The Higher Education Innovation Fund was introduced in 2002–03 to support the full range of university knowledge exchange activity across all sizes of business and the public and not-for-profit sectors. Funding takes the form of block grants calculated on a formula basis which has changed over time. The scheme has been reformed to increase the funding to universities that can demonstrate the most effective patterns of business engagement in their strategic bid for HEIF funds.</p>	‘Third stream’ engagement funding for universities
	<p>The scheme typically allocates between £110–150 million (approximately \$A235–320 million) per annum to English universities, and is administered by the Higher Education Funding Council for England. Funding is termed as ‘third stream’ which reflects the fact that the flow of funds to universities from this source is in addition to the two core elements of the dual funding structure for UK universities. This measure is discussed in greater detail in Box 2.16.</p>	

The United Kingdom continued.

<p>Knowledge Transfer Partnership Scheme</p>	<p>The Knowledge Transfer Partnership (KTP) Scheme originated in 1975 as the Teaching Company Scheme. Subsequently renamed, it funds the exchange of graduate students between universities and firms. It is delivered through Innovate UK. In 2012–13 the KTP Scheme had a budget of around £17 million (approximately \$A36.1 million). Under the Scheme a graduate (known as an associate) works for a firm usually for a two year period on a specific knowledge-transfer project central to a firm's development. A recent review found that 62 per cent of associates have subsequently been offered a permanent job with the firm and 82 per cent of offers have been accepted. The KTP Scheme is an important pathway to translation through the movement of people.</p> <p>KTPs are delivered through Innovate-UK. The program, then known as the Teaching Companies Scheme, originated in 1975. Under this program a graduate (known as an associate) works for a firm, usually for a two year period, on a specific knowledge-transfer project central to a firm's development. The technology that is subject to the knowledge transfer originates within a university. A wide range of knowledge exchange activities are undertaken spanning management; marketing, business administration and policy; engineering technology; and IT, computer science and computation. Associates are jointly supervised by staff in the company and in the faculty at the university concerned.</p> <p>The partnerships are part-funded by the Government and part by the participating business. In 2008–09 total expenditure under the Program was around £100 million (approximately \$A219 million), of which £30 million was from the Technology Strategy Board (now Innovate UK), £11 million from other government sources and £63 million from business. The average annual SME contribution to a project is around £20,000 (approximately \$A44,000). In 2009 some 96 higher education institutions started new KTPs. Twenty institutions accounted for about half of the 977 active KTPs. This measure is discussed in greater detail in Box 2.8.</p>	<p>Knowledge transfer through recent graduates</p>
<p>Scotland's Interface Program</p>	<p>Interface is an independent and impartial broker that was originally created by the Scottish Universities with funding support from the Public Sector. Interface now has a long established track record of translating the needs of industry and facilitating partnerships between industry and academia. The following services are provided free of charge to clients by Interface:</p> <ul style="list-style-type: none"> • Bespoke translation and brokerage to match business requirements and academic expertise. • Facilitation of collaborative projects between businesses and researchers through knowledge sharing and co-creation of solutions to support the development and commercialisation of new products and processes. • Establishing multi-party collaborative projects where groups of businesses and academics look to solve industry wide challenges. • Access to cutting edge and cost effective facilities and existing technologies. • Advice on innovation related funding streams—most notably managing the various Innovation Voucher Schemes. <p>Interface administers Innovation Vouchers (up to £5,000), Student Placement Innovation Vouchers (up to £5,000), Follow On Innovation Vouchers (up to £20,000), Horizon 2020 SME Engagement Scheme (up to £5,000), Interface Food & Drink Funding (up to £25,000), and additional funding streams. Interface also works new and emerging Innovation Centres (Interface 2015).</p> <p>Interface is funded by the Scottish Funding Council, Scottish Enterprise, Highlands & Islands Enterprise, The Scottish Government, and the European Regional Development Fund. The annual budget is around £1 million (approximately \$A2.1 million) and includes 22 staff members across Scotland. This measure is discussed in greater detail in Box 2.23.</p>	<p>Intermediary</p>

The United States of America

The Bayh-Dole Act and Stevenson-Wydler Acts	<p>Prior to 1980, the intellectual property from most US Government-funded research was owned by the Government. Only 5 per cent of government-owned patents were commercialised. The Bayh-Dole Act provided conditions under which universities and small businesses can choose to retain title to an invention from federally-funded R&D. The Government retains a non-exclusive, non-transferable, paid-up license to practice any such invention, and retains certain 'march-in' rights. An enormous surge in commercialisation activity has taken place since the Bayh-Dole Act became law.</p> <p>The Stevenson-Wydler Act provided a framework for private sector firms to commercialise outcomes from joint research projects with federal laboratories. For more information see Appendix B.</p>	Strategy for innovation and translation
Cooperative Research and Development Agreements between federal research laboratories and industry (CRADAs)	<p>Amendments to the 1980 Stevenson-Wydler Technology Innovation Act led to the Federal Technology Transfer Act (FTTA) of 1986. The FTTA established the legislative authority for the Cooperative Research and Development Agreement (CRADA) to be used by all federal R&D agencies to conduct R&D of mutual interest jointly with firms and consortia of firms. The FTTA permits firms to retain the title to inventions resulting from R&D conducted under CRADAs, with the Government maintaining its usual right to a royalty-free license.</p> <p>CRADAs are one of a number of mechanisms available to the federal laboratories for engaging in technology transfer and commercialisation and have become the most visible instrument of transfer, as well as the metric by which many laboratories' success is measured. In the original concept no funds were exchanged between the federal laboratory and industry. Instead, both supported their own efforts, but they could engage in joint agenda setting, divide the specific research tasks among themselves, and could share the results with each other. It was expected that CRADA industrial partners would contribute not just money but also technical effort to the collaboration.</p> <p>Both Government-owned Government-operated laboratories, and Government owned contractor operated laboratories are authorized to use CRADAs. Partners can be business firms, universities, and not-for-profit organisations, but preference is extended to SMEs and to firms that agree to manufacture any resulting products in the US. The number of CRADAs has risen from 34 in 1987 to 8,800 in 2012. This measure is discussed in greater detail in Box 2.11.</p>	Similar to Australian CRCs but limited to government laboratories

The United States of America continued.

<p>The National Science Foundation (NSF): Engineering Research Centers Program (ERCs)</p>	<p>The ERCs were established in 1985 by the National Science Foundation based on the success of the Industry-University Cooperative Research Centers program (IUCRC). The ERCs aimed to stimulate the formation of university-based industrial consortia while at the same time seeking to change the context of engineering research and education. Objectives were to increase US industrial competitiveness, promote interdisciplinary research and teaching, foster a team approach to research, and introduce students to industry needs and perspectives. ERCs are complex organizations and seek to achieve multiple objectives, account to multiple stakeholders, depend on multiple funding streams, and produce multiple outputs. It was not anticipated that the ERCs would become directly involved in commercialising new technologies or take equity positions in spin-off companies intended to commercialise new technologies.</p> <p>NSF supports each ERC for eleven years (subject to intensive reviews every three years) at an average level of \$2 million (approximately \$A2.75 million) annually for each centre. A typical ERC has 30 industrial members, with full members contributing an average of \$US20,000 in membership fees. But the average annual budget of an ERC is \$US10 million, representing support from other parties as well. Roughly 30 per cent of an ERC's annual budget comes from NSF and another 30 per cent from industry; the remainder comes from other Federal agencies (20 per cent), the host university (10 per cent), and state and local and other sources (10 per cent). Participation in ERCs was more so to gain access to new ideas and know-how rather than the ability to license ERC inventions and software.</p>	<p>Similar to Australian CRCs</p>
<p>The Small Business Technology Transfer Program (SBTR)</p>	<p>The Small Business Technology Transfer (STTR) Program was modelled closely on the Small Business Innovation Research (SBIR) Program, and includes the participation of five US Government agencies. The STTR program was developed to facilitate the movement of promising concepts originating in not-for-profit research organisations (largely federally funded) to commercialisation by SMEs. To be eligible for an STTR Award, a small business must collaborate with a not-for-profit research institution: a university, a federally laboratory or similar organisation. Legislation authorised agencies with an external R&D budget greater than \$US1 billion were required to set aside not less than 0.05 percent of this budget for STTR awards in 1994. The STTR Program has since been reauthorised several times, and the amount set aside for STTR awards has increased several times, to an allocation of not less than 0.45 per cent of each agency's external R&D budget for the 2016 financial year and beyond. In the period 2001–12 around \$US262 billion (approximately \$A360.2 billion) was awarded through this program. This measure is discussed in greater detail in Box 2.5.</p>	<p>Research commercialisation</p>

Appendix B

The US Bayh-Dole and Stevenson-Wydler Acts

Bayh-Dole Act

The Bayh-Dole Act or Patent and Trademark Law Amendments Act (Public Law 96-517, December 12, 1980) addressed ownership of inventions arising from federally funded research.

Before the Bayh-Dole Act, federal research funding contracts and grants obligated inventors in both the public and private sectors to assign inventions from federally funding research to the US government. This led to a situation, reported by the General Accounting Office (GAO 1978) where, prior to Bayh-Dole, the US Government had accumulated 28,000 patents but fewer than 5 per cent were commercially licensed. Universities and businesses wanting to exploit the outcomes of federally funded research projects faced a wide range of rules and regulations that varied between agencies. There was no uniform federal policy on patents for government-sponsored inventions or on the transfer of technology from the government to the private sector.

The Bayh-Dole Act gives universities, small businesses, and not-for-profit organisations the option to own such inventions and take steps to commercialise them. In summary, they must:

- include the patent rights clause in any subcontracts
- report subject inventions to the funding agency
- elect in writing whether or not to retain title
- conduct a program of education for employees regarding the importance of timely disclosure, and

- require certain employees to make a written agreement to protect the government's interest in subject inventions.

Organisations that decide to take title to an invention must:

- grant to the government a nonexclusive, non-transferable, irrevocable license
- file its initial patent application within one year after its election to retain title
- notify the government if it discontinues an application or plans to let a patent lapse
- give the Federal agency, on request, title to any invention if the organisation fails to file, does not continue a prosecution, or plans to allow a patent to lapse
- in each patent include a statement that identifies the contract under which the invention was made and notice of the government's rights
- report on the utilisation of federally funded inventions
- require in exclusive licenses to use or sell in the USA that products will be manufactured substantially in the United States, and
- agree to allow the government to 'march in' and require licenses to be granted, or to grant licenses, in certain circumstances (this provision has not been used).

Certain additional requirements apply to not-for-profit organisations.

The Bayh-Dole Act has been reviewed, most recently by the US National Academy of Sciences (NAS, 2011). The NAS found that:

The system put in place by the Bayh-Dole Act, that is, university ownership of inventions from publicly funded research and latitude in exercising associated IP rights subject to certain conditions and limitations, is unquestionably more effective than its predecessor system—government ownership subject to waiver in circumstances that varied from agency to agency—in making research advances available to the public.

The Bayh-Dole legal framework and the practices of universities have not seriously undermined academic norms of uninhibited inquiry, open communication, or faculty advancement based on scholarly merit. There is little evidence that IP considerations interfere with other important avenues of transferring research results to development and commercial use.

A persuasive case has not been made for converting to an inventor ownership or 'free agency' system in which inventors are able to dispose their inventions without university administration approval. If evidence is developed suggesting that either approach would be more effective than the current system, other significant practical consequences and policy issues would have to be considered, such as the potential for conflicts of interest and adverse effects on public accountability.

Nevertheless, proposals to empower faculty and other university-based inventors by giving them ownership or rights to market their inventions independent of university oversight reflect a feeling in some quarters that in the current system of university management, inventor initiative is not sufficiently valued and encouraged. In fact, successful commercialization often depends on active inventor engagement and, in some cases, inventors playing a lead role.

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Stevenson Wydler Act

The Stevenson-Wydler Technology Innovation Act of 1980 (Public Law 96–480) (94 Stat. 2311) requires that US federal government laboratories actively fund and participate in technology transfer activities. The Act provides for public dissemination of information about research outcomes and requires federal government laboratories to actively engage in the technology transfer process. Federal government laboratories are required to set apart a percentage of their budget specifically for technology transfer activities. The Stevenson-Wydler Act was amended by the Federal Technology Transfer Act of 1986 and the America COMPETES Act of 2007 (Public Law 110-69) and America COMPETES Reauthorization Act of 2010 (Public Law 111-358).

Appendix C

The use of concessional loans to support research translation and start-ups

A number of governments offer loans to stimulate innovative activity by researchers and businesses and facilitate the translation of research by providing funds when other financial institutions are not willing to invest. While these loans are available to projects that are jointly undertaken between public sector researchers and firms, the loan is normally provided to the firm. There are many examples of different types of loan measures. The country examples discussed here are listed in alphabetical order.

Brazil

The Brazilian Innovation Agency, **FINEP**, commits a portion of its budget for innovation finance loans with enterprises. It acts as a bank, issuing loans to firms investing in innovation. In July 2013, FINEP made R\$640 million (approximately \$A225 million) available to support incubators and technological parks as well as their resident companies. Support is provided to incubators and technological parks through loans to and equity investments in the resident companies (and to firms having graduated in the past two years). Subsequently, R\$500m (approximately \$A176 million) was offered through loans under the eligibility and financing terms of the Innovate Company Brazil Programme.

The Zero Interest Rate Program (JURO ZERO), administered by FINEP, offers reduced interest

loans which can reach close to zero interest for innovative SMEs at incubation and seed stages. This support includes the creation of university spinoffs. It also awards locally competitive milestone-based small grants of up to R\$200,000 (approximately \$A70,000) to start-ups. The loans are to be reimbursed without any interest in 100 instalments (OECD, 2010).

The **Brazilian Development Bank** also provides resources in the forms of loans, equity participation and through the FUNTEC research grants programme.

Canada

The Government of Canada provides loans to firms, sometimes forgivable in whole or in part, to offset risks associated with new technology development and for support in undertaking global competition. Loans are normally provided through industry partnership programs such as the **Strategic Aerospace Development Initiative (SADI)**, the **Business Development Bank of Canada**, or **Technology Partnerships Canada**. SADI, launched in 2007, provides repayable contributions to support R&D projects in the aerospace, space, defence and security sectors. SADI is available to firms of all sizes to support product, service or process innovation. The Program is managed by Industry Canada's Industrial Technologies Office.

China

Innofund, the Innovation Fund for Technology-Based Firms) was established by central government in 1999 to support the development of newly established technology based SMEs. Support includes subsidies to interest on loans and grants. The Ministry of Science & Technology (MoST) and the Ministry of Finance (MoF) are responsible for management the Fund. The Innofund is open to all China-based technological SMEs, however priority is given to high-technology and new enterprises and start-ups founded by overseas returnees. The overall budget in 2012 was approximately \$A689 million) (ERAWATCH, 2015).

Denmark

Vækstfonden, the Danish Growth Fund introduced subordinated loans in 2013 to facilitate the access of SMEs to debt financing. Several types of loans are available to eligible companies. The types of loans are listed below:

- A company may be granted as a loan as part of an expansion plan. The minimum threshold for a loan is DKK 2 million and the interest rate is typically a few per cent higher than the bank rate.

- Entrepreneur loans are targeted at young, established companies that have products and customers, but find it difficult to obtain financing. The minimum amount of a loan for entrepreneurs is DKK 2 million.
- Subordinated loans are given to companies that are well-established but where bank finance, on its own, is not available. The minimum amount of the loan is DKK 3 million and must be part of a complete financing solution that includes financing from banks and other lenders. No collateral is required.

Finland

The Finnish Funding Agency for Technology and Innovation, **Tekes**, provides funding for companies' projects in the form of a loan or a grant and the type of funding depends on the goals and the content of the project. A loan may be awarded for development work and piloting, and the loan has a low rate of interest and is without collateral. If a project does not achieve its goals and the results cannot be commercialised, a proportion of the loan may afterwards converted into a grant. Loans can be partially obtained in advance. In 2014, Tekes funded 2,750 projects to the value of €550 million (approximately \$A886 million), with 30 per cent for loans to start-up companies.

Germany

The EXIST Program targets spin-offs from public research institutions and universities as well as corporate spin-offs. On average, start-up projects receive funding of about €0.5 million (approximately \$A805,000). Funding is delivered through a combination of equity investment and a second-tier loan. In the first year, enterprises are exempt from paying interest.

The ERP Innovation Program offers SMEs a loan which typically consists of two tranches: a classical bank loan (though offering below market-rate interest rates), requiring collateral as a normal bank loan would, and a subordinate loan (50–60 per cent of the total loan, depending on the amount involved).

These loans are provided from the ERP Special Fund and can thus be offered at lower interest rates. There are special low interest rates for very small firms.

For the subordinate loan, no collateral is needed. The loan is delivered through the SME's bank, which receives the money to finance the loan from the state-owned KfW Banking Group. Repayment of the loan typically starts after 2 years for the bank loan tranche and after 7 years for the subordinated loan tranche.

Loans can cover up to 100 per cent of eligible costs, up to a maximum of €5 million (approximately \$A8 million) per project. Projects that are linked to the energy reforms are eligible for loans of up to €25 million euros per project. The cap for individual companies is €50 million (approximately \$A80.5 million) per calendar-year.

Ireland

The Microenterprise Loan Fund, provides support in the form of loans for up to €25,000 (approximately \$A40,000), available to start-up, newly established, or growing microenterprises employing less than 10 people, with viable business propositions, that do not meet the conventional risk criteria applied by banks. The Loan Fund is only available to applicants who have had their request for loan finance declined by the Banks.

Korea

The Korea Credit Guarantee Fund (KODIT) was established by legislation in 1976 with the objective to lead the development of the economy by extending credit guarantees for SMEs that have future prospects but lack tangible collateral. At the end of 2014, the total capital funds of KODIT were KRW 5,702 billion (approximately \$A6.8 billion). *The Industrial Technology Development Loan Fund* of the Ministry of Commerce, Industry, & Energy provides long-term low interest loans to promote the local development of major capital goods and advanced technology products and encourage the uptake of new technology.

Sweden

Inlandsinnovation AB is a state-owned venture capital company that has also entered into loan agreements with six companies amounting to SEK 218 million (€24 million). *The ALMI Innovation Fund* offers advisory service, loans and venture capital. Innovation loans are provided to commercialise innovative projects. Eligible costs include product or service development, market research or protection of intellectual property rights. In 2011 the budget was SEK 20 million (approximately \$A38.6 million). The budget can be used for the following levels of loans:

- for loans up to SEK 50,000 (€5,741) the loan can cover up to 50 per cent of the total investment
- for loans up to SEK 300,000 (approximately \$A55,500) the loan can fund up to SEK 250 per hour of project time
- for loans over SEK 300,000, at least 50 per cent of the co-financing must be own funding, bank or other external funding
- interest rates are slightly above bank interest rates.

ALMI Business Loans offers advisory services, loans and venture capital. This support is aimed at companies with up to 250 employees with growth potential. The total amount committed in 2011 was SEK 1.9 billion (approximately \$A338 million).

United Kingdom

The Enterprise Finance Guarantee is a government lending initiative for small businesses with viable business proposals that lack security for conventional lending. It was launched in 2009 and has lent over £900 million (approximately \$A1.9 billion) to 9,000 small businesses across the UK, that otherwise would not have been able to access finance due to a lack of available security. In 2015–16 it is expected to provide guarantees up to £500 million (approximately \$A1.1 billion) (Department for Business Innovation and Skills (UK), 2015).

USA

The Georgia Research Alliance is an independent not-for-profit organisation funded by state appropriations since 1993. Its operating budget is also supported by industry and foundation contributions. The GRA Ventures program promotes commercialisation of university-based technologies through grants and low-interest loans to start-ups. It has provided \$8 million in low-interest loans to 35 promising companies.

Innovation Ohio Loan Fund (IOF) provides subsidised debt financing to established companies. The IOF Loan Fund may finance up to 75 per cent of allowable project costs with loans ranging in size from \$US0.5–1.5 million (approximately \$A0.7–2.1 million). The loan interest rate is fixed at or below private sector loans for comparable levels of risk.

Appendix D

Innovate UK

Innovate UK is the UK's innovation agency. It is an incorporated body, originally established as the Technology Strategy Board. It began operations in July 2007. It is a business-led executive organisation. Innovate UK has a twelve-member Governing Board and is funded through the UK Department for Business, Innovation & Skills (BIS).

Innovate UK's role is to fund, support and connect innovative British businesses through a unique mix of people and programs to accelerate sustainable economic growth. The businesses whose projects receive support range from pre-start-up and early-stage micro companies to larger corporates and multinationals. Innovate UK's role is to help companies take their ideas to market by providing them with an array of programs and tools.

Funding options for research, development and demonstration projects range from proof of concept grants and feasibility studies to large multi-partner collaborative research and development projects. Innovate UK also offers knowledge sharing opportunities for academia and business, facilitate networking to boost open innovation and provide the route for UK businesses to access European support for innovation and technology.

In 2011 Innovate UK launched a four-year Strategy designed to accelerate economic growth by stimulating and supporting business led innovation. The Strategy *Concept to Commercialisation* had a budget of more than £1bn (approximately \$A2.2 billion) over the period. This was expected to generate investment

in innovation of around £2.5 billion, including contributions from business and partners. The Strategy concentrated on five strategic themes:

- Accelerating the journey between concept and commercialisation
- Connecting the innovation landscape
- Turning government action into business opportunity
- Investing in priority areas based on potential
- Continuously improving UK capability.

Financial year 2014–15 was the last year of this corporate strategy. Innovate UK is now undertaking a review process to develop a new strategy for the period 2015–20. Innovate UK currently operates several programs that support research collaboration, help high-potential SMEs to bring their ideas more rapidly to market, and assist more mature businesses seeking to deliver stronger growth. These include:

Catalysts focus on priority areas where the UK research base has a leading position and where a clear commercial potential exists. Catalysts provide funding to innovative businesses and researchers working in priority areas offering a clear and progressive route for development. Catalysts are open for proposals at any time. There are currently four Catalysts: The Biomedical Catalyst, the Agri-Tech Catalyst, the Industrial Biotechnology Catalyst, and the Energy Catalyst. The first three of these are operated in partnership with the relevant research council.

Catapult centres are technology and innovation centres where the best of the UK's businesses, scientists and engineers can work side by side on research and development, transforming ideas into new products and services to generate economic growth. Catapults help businesses adopt, develop and exploit innovative products and technologies. Seven Catapults are in operation in areas identified as strategically important and where there is genuine potential for the UK to gain competitive advantage. They are:

- High Value Manufacturing
- Cell Therapy
- Offshore Renewable Energy
- Satellite Applications
- Digital
- Future Cities
- Transport Systems.

Two new Catapult centres—Energy Systems and Precision Medicine—were announced in November 2014 and will open in 2015.

Innovation vouchers have been available to start-ups, micro businesses and SMEs. These have been worth up to £5,000 so that they can seek specialist knowledge to help them innovate, develop and grow. Vouchers are awarded on

a quarterly basis and are now available to businesses in any sector. In the financial year 2014–15, Innovate UK awarded around 1,000 vouchers with a total value of approximately £4.8m.

The Smart Scheme offers funding to SMEs to engage in the strategically important areas of science, engineering and technology, from which successful new products, processes and services could emerge. It provides funding to pre-start-ups, micro businesses and SMEs to invest in R&D and innovation. The 2014–15 budget for this scheme is £50m. Some 516 grants were issued during the previous financial year.

Knowledge Transfer Partnerships (KTPs) help UK businesses improve their competitiveness, productivity and performance by accessing the knowledge, technology and skills available in our world-class universities, colleges and research organisations. There were nearly 800 projects in the portfolio at the end of the year 2014–15. Innovate UK and sixteen other funding organisations committed £36m on new projects during this period.

Other Innovate UK activities include organising missions to other countries, investments in SME clusters, the Knowledge Transfer Network, linking business to investment sources and growth services and procurement standards to stimulate innovation.

Expert Working Group

Dr John Bell FTSE (Chair)

John is a senior Associate with ACIL Allen Consulting. He has held senior positions with the Commonwealth Government, including Deputy Secretary and Chief Science Adviser in the (now) Department of Industry. He has also spent more than seven years working with the Organisation for Economic Co-operation and Development (OECD) in Paris, including four years as Head of the Division responsible for analysis of science, technology and innovation. In 2003, Dr Bell was awarded a Centenary of Federation medal for his strategic contribution to research and development in Australia.

Professor Mark Dodgson FASSA

Mark is Professor of Innovation Management at the University of Queensland Business School and Visiting Professor at Imperial College Business School, London. Over the past 30 years he has researched and taught innovation in 60 countries. He has produced 16 books and over 100 academic articles and book chapters on innovation. He spent 10 years as Senior Fellow at the Science Policy Research Unit at the University of Sussex and 10 years at the Australian National University where he was Executive Director of the National Graduate School of Management. Mark has been a director of Nestlé Australia, Thiess Pty Ltd., and the Think, Play, Do Group. He has been an advisor to companies and governments on their innovation strategies and policies in many countries around the world.

Professor Les Field AM FAA

Professor Field is currently the Chair of the Deputy and Pro Vice-Chancellors (Research) Committees for both the Group of Eight and Universities Australia and serves as a Director on numerous Boards including the Victor Chang Cardiac Research Institute, New South Innovations (NSi), NICTA and UniSeed. Professor Field is a graduate of the University of Sydney (PhD 1979) and, following Postdoctoral Fellowships at the University of Southern California in Los Angeles and at Oxford, took up a position at the University of Sydney in 1982. He was awarded a DSc by the University of Sydney in 1991. He held the positions of Head of the School of Chemistry (1997–2001), Associate Dean for Research in the Faculty of Science (1998–2001), Deputy Chair of the Academic Board and Chair of the University Research Committee (1999–2001), and Acting Deputy Vice-Chancellor (Research) (2001–03). In 2005, Professor Field was appointed as Deputy Vice-Chancellor (Research) at the University of New South Wales.

Professor Paul Gough

Paul is Pro Vice-Chancellor of the College of Design and Social Context RMIT and Vice-President RMIT University. A painter, author and broadcaster he has exhibited globally, has authored over 100 articles on representation of conflict, remembrance and commemoration, and published 6 books on war artists. He has been appointed to a number of committees including

the UK Strategic Advisory Group of the Arts and Humanities Research Council (AHRC), HEFCE Research Capability Fund panel, and chair of the five year AHRC 'Landscape and Environment' commissioning panel. He was a panel member for UK RAE 2001 and Chair of the national Art and Design panel for RAE 2008. He has worked internationally—in Australia, Rumania, and New Zealand—on research assessment exercises. In 2014 he chaired the Research Assessment Exercise panel for arts, design and performing arts in Hong Kong.

Professor Sue Rowley

Professor Rowley has held the following positions: Foundation Professor in Contemporary Australian Arts History at the University of New South Wales, Executive Director for Humanities and Creative Arts at the Australian Research Council (2001–04) and Deputy Vice-Chancellor (Research) at the University of Technology Sydney (2004–09). She chairs the University of Wollongong's Faculty of Creative Arts Advisory Committee and the Executive Council of the UTS Faculty of Design, Architecture and Building and is a member of the Board of UNSW National Institute for Experimental Arts. Sue's current Board memberships include the Creative Industries Innovation Centre and the Australian Centre for the Moving Image (ACMI). Sue Rowley is UTS Emeritus Professor and a consultant in creative industries and university-based research.

Professor Tom Spurling AM FTSE

Professor Tom Spurling is Professor of Innovation Studies at the Centre for Transformative Innovation, Swinburne University of Technology. He was a member of the CSIRO Board until June 2015 and is the Chair of the Board of Advanced Molecular Technologies Pty Ltd. He is a Fellow of ATSE and was made a Member of the Order of Australia in 2008 for his contributions to national innovation policies.

All EWG members have declared any relevant interests.

Project Managers

Matt Wenham

Manager, Policy & Projects

Australian Academy of Technological Sciences and Engineering

Sarah Parker

Research & Policy Officer

Australian Academy of Technological Sciences and Engineering

Review Panel

This report has been reviewed by an independent panel of experts. Members of this Review Panel were not asked to endorse the Report's conclusions and findings. The Review Panel members acted in a personal, not organisational, capacity and were asked to declare any conflicts of interest. ACOLA gratefully acknowledges their contribution.

Emeritus Professor Malcolm Gillies FAHA

Malcolm Gillies is a retired vice-chancellor of two universities in London, where he was also chair of the mission group, London Higher, during 2010–14. He is a former vice-president of the Australian National University, president of the Australian Academy of the Humanities, and during 1998–2002 was chair of the National Academies Forum (now, ACOLA).

A musicologist, linguist and educator, he has published widely, particularly about eastern European culture and higher education policy. He is now a Visiting Professor of King's College London and Mathias Corvinus Collegium in Budapest, and a Foundation Board member of Nyenrode Business University in The Netherlands.

Professor Peter Gray FTSE

Professor Peter Gray was appointed in 2003 as the inaugural Director of the Australian Institute of Bioengineering and Nanotechnology (AIBN) at the University of Queensland.

Prior to joining AIBN, he was Professor of Biotechnology and Director of the Bioengineering Centre at the University of New South Wales, and Senior Principal Research Fellow at the Garvan Institute of Medical Research in Sydney. He has held academic positions at University College London, and at the University of California, Berkeley and has had commercial experience in the USA working for Eli Lilly and Co and the Cetus Corporation.

Professor Gray is a founder and a past President of the Australian Biotechnology Association (AusBiotech). He serves on the Boards of Biopharmaceuticals Australia Pty Ltd, ACYTE Biotechnology Pty Ltd, the Advanced Water Management Centre, the Diamantina Institute for Cancer, Immunology and Metabolic Medicine, Engineering Conferences International (ECI) Inc, New York, and on a number of state and federal government committees in the fields of biotechnology, pharmaceuticals and education.

Professor Gray is an active researcher who has published and patented widely in the fields of bioengineering, the production of biopharmaceuticals and stem cell technology.

Laureate Professor Graeme Jameson AO, FAA, FTSE, FEng, NAE (USA)

Laureate Professor Graeme Jameson holds a BSc (UNSW) and a PhD (Cambridge), both in chemical engineering. After leaving Cambridge, he worked for two years in the oil industry in the US, before joining Imperial College London. In 1978, he returned to Australia as Professor of Chemical Engineering at the University of Newcastle, where he remains today.

He is best known for the discovery of a new type of flotation device for the mineral industry, the Jameson Cell, which has been sold world-wide. To date, the Cell has produced export coal valued at over \$36 billion to the Australian economy. He has received many awards, including NSW 2013 Scientist of the Year, and the 2015 Prime Minister's Science Prize for Innovation.

Emeritus Professor Ross Milbourne AO, FASSA, FAICD

Ross Milbourne completed his B.Com and M.Com(Hons) from the University of NSW and Ph.D in Economics from the University of California, Berkeley. He was Assistant then Associate Professor at Queen's University Canada, before being appointed chair of Economics at UNSW. He was a member of the Board of the Australian Research Council and chair of the Large Grants Committee and chair of the Indigenous Researcher Development Program. He was Vice-Chancellor of the University of Technology Sydney from 2012–14. He is a member of the Academy of Social Sciences and Fellow of the Australian Institute of Company Directors.

Evidence gathering

Consultant reports

The contractors were asked to

- conduct a study to describe and analyse at least five measures, which contribute to the commercialisation of public sector research for the nominated country
- include measures such as government and university policies, strategies and programs and measures to ensure the utilisation of intellectual property originating in the public sector.

For each of the measures studied, contractors were asked to provide information on:

- the rationale for the measure
- the outcome(s) of the measure
- operational information, including the types of business, industries, government agencies and other parties (such as not-for-profit organisations) engaged
- administrative responsibility and cost
- any indicators, measures of success and/or evaluations (if available)
- the likely applicability of the measure to the Australian context.

The contractors were asked to draw upon national information sources including reports and studies, citing them where appropriate.

They were also asked to build on research studies, and published data where available. Access to relevant published reports and studies that has been collected by the project secretariat was made available to the contractors.

There was a requirement for contractors to conduct interviews with at least key policy makers.

All contributing reports are listed in the table opposite and can be found at: <http://acola.org.au/index.php/saf09-contributing-reports>.

Workshops and consultations

The Expert Working Group held a major workshop in October 2015, to seek input from key stakeholders to the project and to discuss the preliminary findings in great detail.

The Expert Working Group is grateful to have had the opportunity to consult widely with many experts and key stakeholders during this workshop and also through individual consultations, including:

Professor Jo Barraket, Swinburne University of Technology

Ms Carol Bellettini, Australian Government Department Industry, Innovation and Science

Ms Anna Maria Bonnici, Innovative Research Universities

Dr Tim Boyle, Australian Nuclear Science and Technology Organisation

Ms Sarah Brown, Universities Australia

Professor Aidan Byrne, Australian Research Council

Ms Jacqueline Cooke, Australian Government Department of Industry, Innovation and Science

Dr Kevin Cullen, UNSW Innovations

Professor Matthew Cuthbertson, RMIT University

Mr Dom English, Australian Government Department of Education and Training

Dr Bronwyn Evans, Chair, Medical Technologies and Pharmaceuticals Growth Centre

Ms Kathryn Fagg, Boral, Djerrirwarr Investments, Incitec Pivot, Reserve Bank of Australia

Professor Graham Galloway, National Imaging Facility

Dr Julie Glover, National Health and Medical Research Council

Professor Margaret Harding, Australian National University

Dr Chris Hatherly, Australian Academy of Science

Mr David Henderson, Abernethy Henderson

Mr Philip Heuzenroeder, LESANZ/Spruson & Ferguson

Dr Alastair Hick, Monash University

Ms Renee Hindmarsh, Australian Technology Network

Country reports on measures to encourage and facilitate research translation and application

Report	Authors	Title
Australia	Dr John Howard	<i>Translation of Research for Economic and Social Benefit: Measures that facilitate transfer of knowledge from publicly funded research organisations to industry</i>
Brazil	Professor Antonio José Junqueira Botelho and Mr Alex da Silva Alves	<i>Study of measures to encourage the translation of public sector research for economic and social benefit for Brazil</i>
Canada	Jack E. Smith and Jason van Dieen	<i>Review of Public Research Commercialization Instruments: A Study of Canadian Public Policy and Business Partnership Mechanisms Used for Commercialization of Public R&D</i>
Chile	Camila Chávez	<i>A Study of Measures to Encourage the Translation of Public Sector Research for Economic and Social Benefit in Chile</i>
China	Ms Yuan Gao	<i>Measures that facilitate transfer of knowledge from publicly funded research organisations to industry in China</i>
Denmark	Professor Ron Johnston FTSE	<i>A Study of Measures to Encourage the Translation of Public Sector Research for Economic and Social Benefit in Denmark</i>
Finland	Professor Ron Johnston FTSE	<i>A Study of Measures to Encourage the Translation of Public Sector Research for Economic and Social Benefit in Finland.</i>
Germany	Professor Ron Johnston FTSE	<i>A Study of Measures to Encourage the Translation of Public Sector Research for Economic and Social Benefit in Germany</i>
Israel	Dr Moshe Shahaf	<i>A Study of Measures to Encourage the Translation of Public Sector Research for Economic and Social Benefit in Israel</i>
Japan	Dr Nomi Toshihiko	<i>Review of Japan's Policy Measures for Public Research Commercialization</i>
Korea	Dr Woosung Lee	<i>Commercialization of Public Research: Korean Cases.</i>
Sweden	Professor Ron Johnston FTSE	<i>A Study of Measures to Encourage the Translation of Public Sector Research for Economic and Social Benefit in Sweden</i>
Singapore	Mr Calvin Chu, Ms Ankita Gupta and Mr Frederic Schmidt	<i>Improving Commercialization of Publicly-Funded Research: Singapore</i>
United Kingdom	Professor Alan Hughes	<i>Review of approaches to the commercialisation of university research and support for university industry collaboration in the UK</i>
United States of America	Professor David Roessner	<i>Selected U.S. Measures to Promote the Transfer and Commercialization of Public Sector Research</i>

Dr John Howard, UTS Business School
 Mr Michael Hubbard, Business Council of Australia
 Ms Catriona Jackson, Science & Technology Australia
 Professor Ron Johnston, Australian Centre for Innovation
 Professor Peter Klinken, Chief Scientist of WA
 Ms Anne-Marie Lansdown, Universities Australia
 Mr Peter Laver, ATSE
 Mr Joseph Lawrence, Monash University
 Dr Larry Marshall, CSIRO
 Professor Jim McCluskey, The University of Melbourne
 Mr Rohan McDougall, Knowledge Commercialisation Australia
 Mr Luke Meehan, IP Australia
 Professor Tony Peacock, Cooperative Research Centres Association
 Ms Zoe Piper, Australian Chamber of Commerce & Industry
 Ms Belinda Robinson, Universities Australia

Professor David Robson, University of Technology Sydney
 Dr Les Rymer
 Dr Len Sciacca, Australian Government Department of Defence, Defence Science & Technology Group
 Ms Jan Tennant, Licensing Executives Society Aus & NZ
 Ms Vicki Thomson, The Group of Eight
 Dr Leonie Walsh, Lead Scientist of Victoria
 Mr Ian Watt, Chair, Review of Research Policy and Funding Arrangements
 Professor Elizabeth Webster, Swinburne University of Technology
 Professor Glenn Wightwick, University of Technology Sydney
 Mr Andrew Wilkinson, IP Australia
 Dr Katherine Woodthorpe, Capital Markets CRC
 Dr Nick Yazidjoglou, Australian Government Department of Industry, Innovation and Science
 Ms Anne Younger, The Australian Industry Group

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About Securing Australia's Future

In June 2012 the Australian Government announced *Securing Australia's Future*, a \$10 million investment funded by the Australian Research Council in a series of strategic research projects. Projects are delivered to the Commonwealth Science Council by the Australian Council of Learned Academies (ACOLA) via the Office of the Chief Scientist and the Australian Chief Scientist.

Securing Australia's Future is a response to global and national changes and the opportunities and challenges of an economy in transition. Productivity and economic growth will result from: an increased understanding in how to best stimulate and support creativity, innovation and adaptability; an education system that values the pursuit of knowledge across all domains, including science, technology, engineering and mathematics; and an increased willingness to support change through effective risk management.

Six initial research topics were identified:

- i. Australia's comparative advantage
- ii. STEM: Country comparisons
- iii. Smart engagement with Asia: leveraging language, research and culture
- iv. The role of science, research and technology in lifting Australian productivity
- v. New technologies and their role in our security, cultural, democratic, social and economic systems
- vi. Engineering energy: unconventional gas production

Five further research topics have been identified:

- vii. Australia's agricultural future
- viii. Delivering sustainable urban mobility
- ix. Translating research for economic and social benefit: country comparisons
- x. Capabilities for Australian enterprise innovation
- xi. Business diasporas in Australia: maximising people to people relationships with Asia

The Program Steering Committee responsible for the overall quality of the program, including selection of the Expert Working Groups and the peer review process, is comprised of three Fellows from each of the four Learned Academies:

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