MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
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SCIENCE SYSTEM ADVISORY GROUP

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TITLE	Background to New Zealand's Science, Innovation and Technology system		
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AUTHOR/S	Jill Fernandes, Nic Scott		
PURPOSE	To provide an overview of New Zealand's science, innovation and technology system including; organisations, funding, the research workforce and the outputs of research, including relevant international comparisons		

Contents

Introduction

The Science System Advisory Group (SSAG) has been asked to develop a set of evidence-based recommendations to strengthen New Zealand's science, innovation and technology system and ensure its future success.

To support the SSAG in its role, the secretariat has prepared this background document on the New Zealand SI&T system. It outlines the current state of SI&T in New Zealand using comparative quantitative indicators, where they are available. It also contains information on the funding landscape, our research strengths, workforce, commercialisation, Māori interests, and research infrastructure.

This document is a brief, outline summary of information available on New Zealand's SI&T system. It is intended to be introductory, rather than comprehensive. The secretariat will be happy to provide more information and detail on these topics on request.

Small Advanced Economies

The Small Advanced Economies Initiative is a collaboration between Denmark, Finland, Ireland, Israel, New Zealand, Singapore, and Switzerland. All of the countries are advanced economies by International Monetary Fund standards, and are of similar scale in terms of population with around 5 to 10 million inhabitants.

These countries form a sensible comparator group for New Zealand and so are included for reference in most comparative statistics in this briefing. Where available, we have also included a comparison with Australia (New Zealand's closest geographic neighbour and largest trading partner), and the OECD average.

Section 1: The Size and Shape of the System

The most comparable measure of the amount of R&D that happens in New Zealand is on an expenditure basis, where expenditure is used as a proxy for the amount of R&D activity. On this basis, New Zealand's R&D activity is small compared to most other small advanced economies (SAEs). Expenditure is growing, but from a low base, and is unlikely to catch up with those economies at current rates of growth.

Overall investment in this system was approximately $5.2 billion[1] in 2022, with government investment accounting for $2.15 billion – around 41 per cent of this. Comparable international data are not available for 2022, so we have used 2021 data for comparisons.

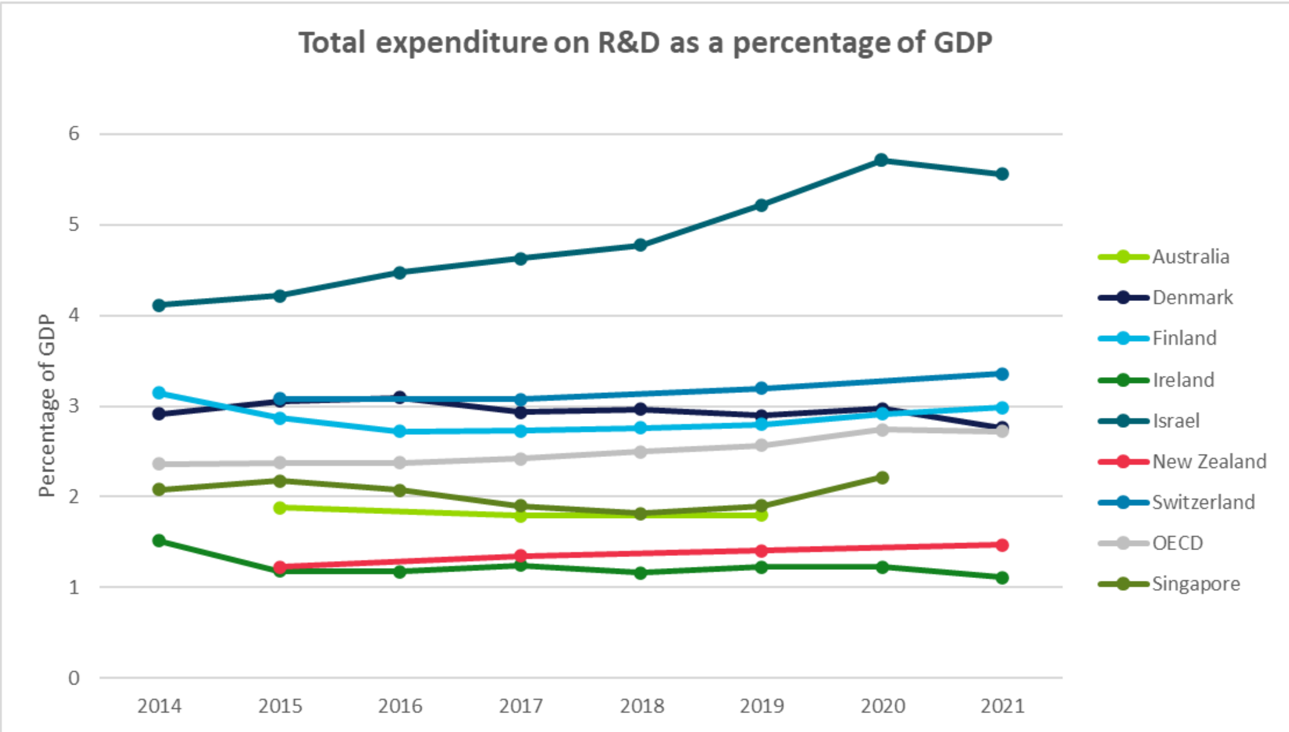


Figure 1: Total expenditure on R&D as a proportion of GDP (Source: OECD Main Science & Technology Indicators)

In 2021, New Zealand spent $4.7 billion on R&D, or 1.47 per cent of GDP, compared to the OECD average of 2.72 per cent. Given that New Zealand also has the lowest GDP of the comparator group of countries, 1.47 per cent also represents an extremely small investment in real terms.

Recent growth in R&D expenditure since 2015 has been driven almost entirely by the business sector, with public investment remaining static in real terms. The growth in business expenditure on R&D is correlated with increases in government support for business R&D over that period. This was initially via grant schemes, and more recently via the introduction of an R&D tax credit.

Section 4 of this briefing provides further data and breakdowns of R&D expenditure.

[1] Dollar figures throughout this briefing refer to New Zealand Dollars, unless otherwise specified.

Section 2: Research Organisations in New Zealand

A range of different types of organisations perform research in New Zealand, including:

- around 2,350 R&D performing businesses (with many more reporting innovation)
- eight Universities
- seven Crown Research Institutes (CRIs)
- many independent research organisations, and
- local and regional government researchers, business accelerators and incubators, and other support functions.

By size of expenditure, businesses account for the majority of New Zealand's R&D, at around 59 per cent. This percentage is roughly comparable to most other advanced economies, but is also quite a recent phenomenon, moving from an historical norm of about 50 per cent around ten years ago.

The next largest set of R&D performing organisations are the Universities, accounting for 24 per cent, followed by CRIs at around 17 per cent. Other research organisations account for much smaller amounts of expenditure.

Crown Research Institutes (~$765 million annually)

CRIs are Crown-owned companies, with boards appointed by the Government, that undertake scientific research for the benefit of New Zealand. Each CRI is aligned with a productive sector of the economy or a grouping of natural resources.

CRIs are unusual organisations in comparison to other countries. In some ways they are analogous to national laboratories or surveys, and in other ways are similar to technology transfer organisations or industry-facing R&D entities. To the extent that there is an international 'norm' for public research organisations, New Zealand is quite different in that –

- CRIs make up a much larger part of the public science system than is usual, accounting for around 40 per cent of public science conducted in New Zealand.
- CRIs are vertically integrated towards their particular user community, and can conduct their own basic science, as well as applied science and service provision.
- All CRIs, whether focused on users in industry, or public good areas such as environmental science, operate independently and commercially under expectations that expenditure will match revenue.

CRIs were constituted in their current form in 1991. Their focus on primary industries, environment, conservation, and natural resources reflects New Zealand's historical industrial strategy, which has been predominantly focussed on agriculture.

New Zealand therefore publishes comparatively more in those subject areas where CRIs are active. CRI outputs explain most of the difference in the profile of New Zealand research publications compared to other OECD countries.

In addition to industry-facing research, CRIs are also key providers of science services to government and industry, such as earthquake and volcano monitoring, and forensic testing. They have roles as custodians of nationally significant collections and databases, and various other official and regulatory roles related to their science service or advisory functions.

Table 1: Areas of research focus and income sources for CRIs

Crown Research Institute	Areas of focus or core purpose	Staff (# of People)	Total revenue ($M)	Revenue from Commercial Activities or service contracts ($Ms)	Government grants MBIE ($000s)
Scion	Forestry, wood product and wood-derived materials and other biomaterial sectors, to create economic value and environmental and social outcomes.	348	64.3	34.6	27.3
AgResearch	Primary industries to: create high value products, move to low-carbon economy, mitigate climate change, reverse decline and maintain biodiversity, maintain overall health of the health of land, water and living systems.	722	177.7	90.2	63.5
Plant and Food Research (PFR)	Horticultural, arable, seafood and food and beverage industries to contribute to economic growth and environmental and social prosperity	975	184.8	58.2	56.8
National Institute for Water and Atmospheric research (NIWA)	Atmospheric and climate science, sustainable management of our freshwater, managing and maximising the benefits of our marine estate	~ 700	186.0	85.0	101.1
GNS Science	Natural hazards, building resilience to natural hazard events, energy futures, environment and climate, land and marine geoscience	507	118.7	21.3 Plus 23.8 to maintain the national seismic	70.6

Crown Research Institute	Areas of focus or core purpose	Staff (# of People)	Total revenue ($M)	Revenue from Commercial Activities or service contracts ($Ms)	Government grants MBIE ($000s)
				monitoring network	
Manaaki Whenua	Management of terrestrial biodiversity and land resources to protect and enhance the terrestrial environment and grow New Zealand's prosperity	529	114.8	26.6	66.4
Environmental Science and Research (ESR)	1. Public health and biosecurity 2. Forensic related to safety, security and justice 3. Environmental safety of freshwater and groundwater 4. Environmental food safety risks 5. Radiation safety	598	123.6	109.6 (government contracts for public health monitoring and forensic services)	14.0

Note that the information in this table is collated from CRI Annual reports for 2022-23 and from the Te Pae Kahurangi Report 2020 (mbie.govt.nz)
Fund types are described in Section 4: The funding landscape

Higher Education (~$1.191 billion annually)

New Zealand's higher education sector includes universities, Te Pūkenga (a collective of institutes of technology, polytechnics and industry training organisations) and te wānanga (publicly owned tertiary institutions that provide education based on Te Ao Māori and incorporate mātauranga Māori).

The eight universities do 95 per cent of research undertaken by the higher education sector and are the primary providers of basic research in New Zealand. New Zealand has only one type of university, which provides a full range of undergraduate and postgraduate teaching and research across a broad range of subjects. New Zealand's universities are weakly specialised compared to some overseas systems. The diversity of research activity of New Zealand universities is generally comparable to universities overseas.

Funding to support University-based research, related capability and infrastructure mainly comes from Government.

Table 2: Measures of size and reputation for New Zealand universities

University	Total Publications	Research staff FTE	Total revenue ($000s)	Research revenue ($000s)	QS World Ranking
Auckland University of Technology	1,326	1476	414,978	24,221	407
Lincoln University	443	656	126,435	32,362	362
Massey University	1,910	3496	555,059	93,800	239
University of Auckland	5,390	5736	1,393,136	$327,000	68
University of Canterbury	1,457	2261	425,781	57,842	256
University of Otago	3,246	4362	810,122	157,129	206
University of Waikato	1,021	1655	263,390	40,737	250
Victoria University of Wellington	1,744	2571	494,125	82,631	241

Information in this table is collated from 2022 annual reports. Total publications are based on analysis of Dimensions Bibliometric data. Research active staff is based on the 2018 PBRF Quality Evaluation round.

Businesses ($3.1 billion)

Businesses are investors in, producers of, and users of R&D. Businesses do 59 per cent of the R&D in New Zealand by expenditure. More researchers work in industry than in public research institutions.

Business R&D expenditure predominantly comes from large entities (those with 100 or more employees), despite the large numbers of small to medium enterprises in New Zealand. Large entities comprised nearly three quarters of business R&D expenditure in 2022, despite accounting for only 15 per cent of entities involved in carrying out R&D.

This pattern of expenditure – that the majority of business R&D is done by a small number of large businesses – is common across most advanced economies. What is unusual about New Zealand is its comparative lack of large businesses, with very few, if any, enterprises that would be considered multinationals by global standards. This factor explains a reasonable part of New Zealand's low overall business R&D investment.

Independent Research Organisations (~$160 million)

IROs are organisations that primarily conduct R&D activities, without being owned or governed by Government. Most IROs are categorised as businesses but they are a diverse grouping, and some receive significant Government funding. Many IROs are members of the Independent Research Association of New Zealand (IRANZ). IRANZ currently has 25 members and a combined annual turnover of $160 million.

Regional Authorities/Councils (~$123 million)

Councils use SI&T activities, such as environmental monitoring and other science services, to improve outcomes for their communities, to inform planning processes and meet legislative obligations. Annual regional sector spending on science, monitoring and related activities totalled approximately $123 million in 2022. This involves a mix of internally conducted research and research contracted from other organisations such as CRIs.

Research funders

Alongside the *research-performing* organisations described above there are a number of *research-funding* organisations that fund research but do not undertake substantial research themselves. These organisations are described in more detail in Section 4: Funding in the New Zealand SI&T system, but we note some of the major funders here:

- The Ministry of Business, Innovation and Employment (MBIE – the largest funder of research in New Zealand)
- The Health Research Council (HRC)
- The Royal Society Te Apārangi, including the Marsden Fund Council
- Callaghan Innovation
- Other government Ministries

Section 3: Māori and the SI&T system

This is a brief summary of the complex and nuanced issues with regards to Māori in the context of SI&T. It is intended to serve as an introduction to group members who are not familiar with the content already. As with all other aspects of this briefing, the secretariat stands ready to provide further information and advice when required.

Māori and the SI&T system

Māori are New Zealand's tangata whenua (indigenous people). There is a unique, specific relationship between Māori and the New Zealand Government, the latter usually referred to as 'The Crown' in this context. This relationship is founded in the Treaty of Waitangi, which was signed in 1840 by representatives of the British Crown and 540 Māori chiefs representing many, though not all, of the hapū (extended families) across pre-New Zealand. All but 39 chiefs signed a Māori-language copy of the Treaty.

Government views the Treaty as one of the major sources of New Zealand's constitution, and therefore often makes specific provision for the relationship with Māori when developing policy. In many cases, this specific provision is required by law.

Within the SI&T system, policy with regards to Māori tends to centre on three matters where the system has not performed well historically. These are –

- Māori participation in SI&T as scientists. There are far fewer Māori scientists in New Zealand than we would expect, meaning that our system suffers from lack of diversity on this count, and loss of subsequent insights from Māori perspectives.
- Māori interacting with the science system as users or beneficiaries of science. Our administrative data suggest we fund fewer projects of specific interest to, for example, the Māori economy or Māori health than we should expect.
- The relationship between mātauranga Māori and the SI&T system (discussed further below).

These matters are sometimes conflated, but often unhelpfully so; for example, Māori should be able to participate fully in science careers in any discipline on a basis equivalent to others.

Mātauranga Māori and the SI&T system

Mātauranga Māori (mātauranga) is a modern term used to describe, broadly, "the body of knowledge originating from Māori ancestors, including the Māori world view and perspectives associated with Māori creativity and cultural practices." It is a distinctive indigenous knowledge system of very significant value.

Some aspects of mātauranga are analogous to what is commonly understood as science, particularly natural sciences. Other aspects are an analogue with activities other countries would consider normal academic pursuits, but not scientific – preservation of history, or creative practice, for example. Some mātauranga consists of activities with purposes other than scientific or academic, such as karakia, and warfare (although these can and have been the subjects of research).

An ideal future state with regards mātauranga Māori is one where its distinctiveness is recognised through specific provision via funding and organisational structures, but in the context of a system which acknowledges its value and is open to interacting where that interaction is appropriate for both parties – for example in transdisciplinary research projects.

Section 4: Funding in the NZ SI&T system

Expenditure on R&D

Expenditure on R&D provides the best available measure of how much R&D is performed in a country, sector or industry. New Zealand's total gross expenditure on R&D (GERD) is growing, but from a low base compared to other small, advanced economies. That expenditure is divided between the business (BERD), higher education (HERD) and government sectors (GovERD) as indicated in the figure below:

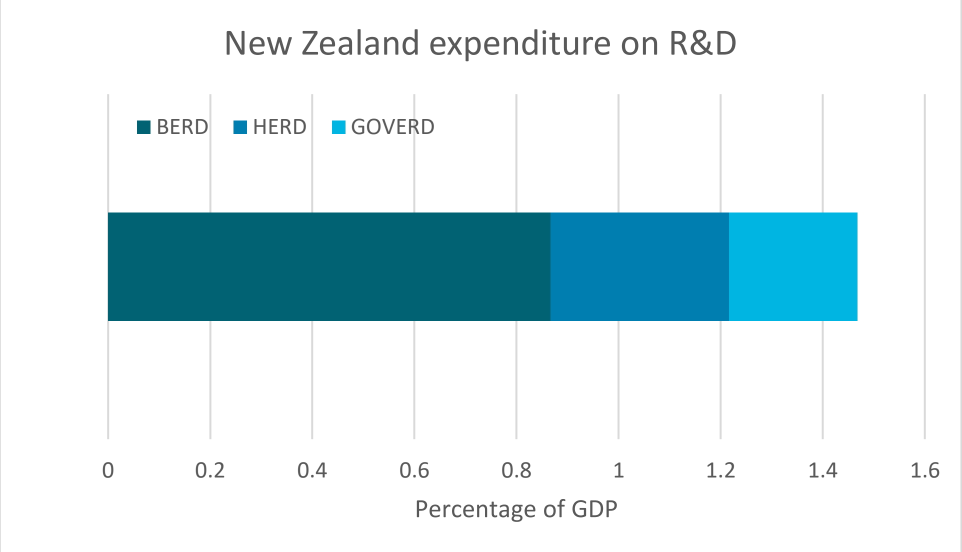


Figure 2: Expenditure on R&D in New Zealand by sector. Data source: OECD main science and technology indicators

BERD, HERD and GovERD as statistics report *expenditure*, that is, who spent the money. They do not say where the money came from, which is a different figure. It is important to bear in mind that –

- Expenditure will be funded by sources from the other sectors. In particular, it is normal for a proportion of BERD to be funded by government via grants or tax incentives.
- GovERD does not represent government funding for R&D; it represents the *value of R&D conducted in government organisations*. This has particular implications for New Zealand, discussed below.

Business expenditure on R&D

New Zealand's business expenditure on R&D (BERD) is 59 per cent, which is low compared to other small, advanced economies and the OECD average of 73 per cent.

Business R&D has grown steadily over the last ten years and has been responsible for the majority of growth in R&D expenditure. The COVID-19 pandemic has had a clear effect on growth in business R&D, and we are yet to see whether the rate of growth will recover to its pre-COVID trajectory. Growth prior to COVID is consistent with international trends for business R&D growth, which suggests that this trend is likely to continue, but also that we need to at least maintain our current rate of growth in order to avoid falling further behind.

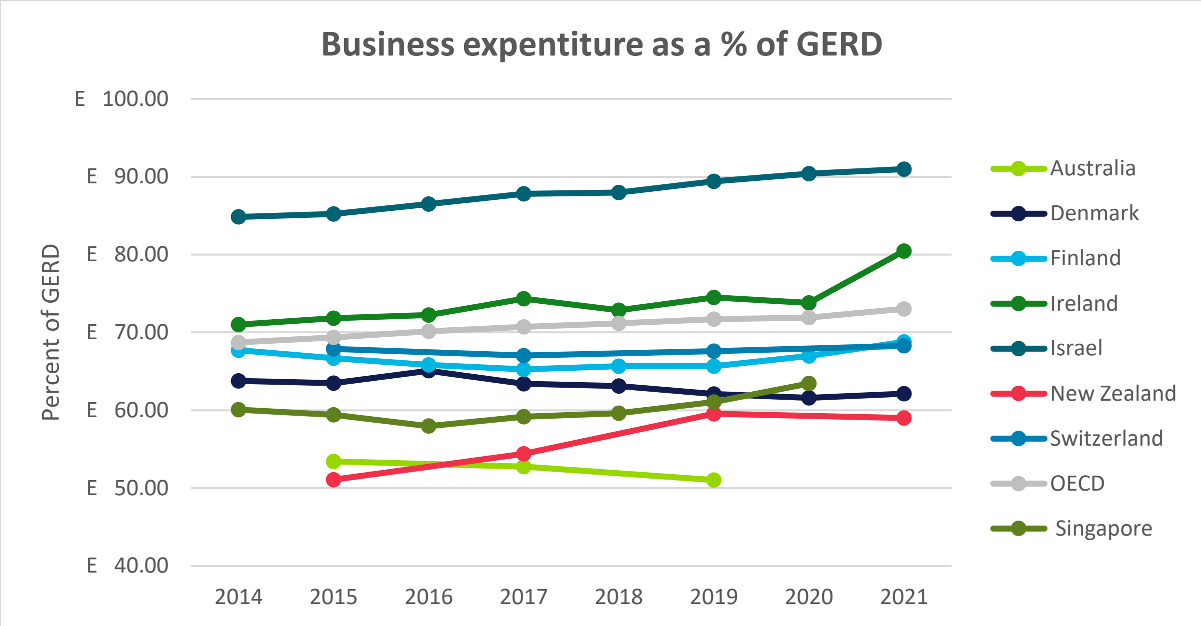


Figure 3: Business expenditure as a percentage of GERD. Data source: OECD main science and technology indicators

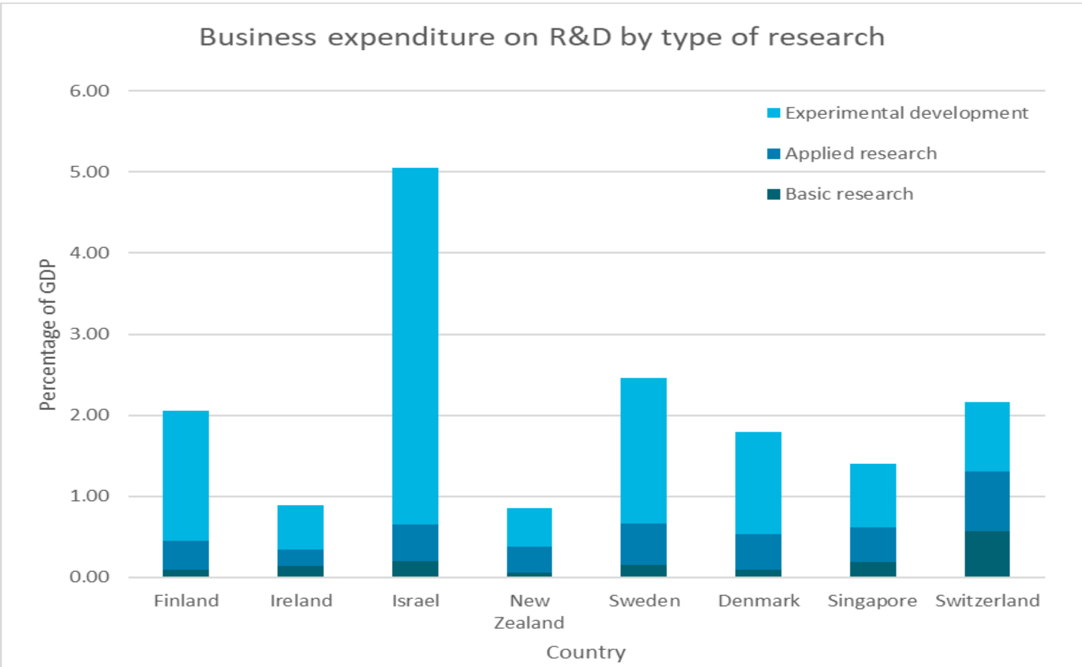


Figure 4: Comparative BERD as a percentage of GDP, and breakdown of that expenditure on basic, applied and experimental research.

Government expenditure on R&D

In New Zealand, Government expenditure on R&D (GovERD) is a much larger proportion of total R&D expenditure compared to other small, advanced countries and the OECD average. In 2021, NZ's GovERD as a percent of GERD was 17.1 per cent, while the OECD average is 8.9 per cent. The recent drop in GovERD as a proportion of GERD is due to the recent increase in BERD, rather than a real drop in GovERD.

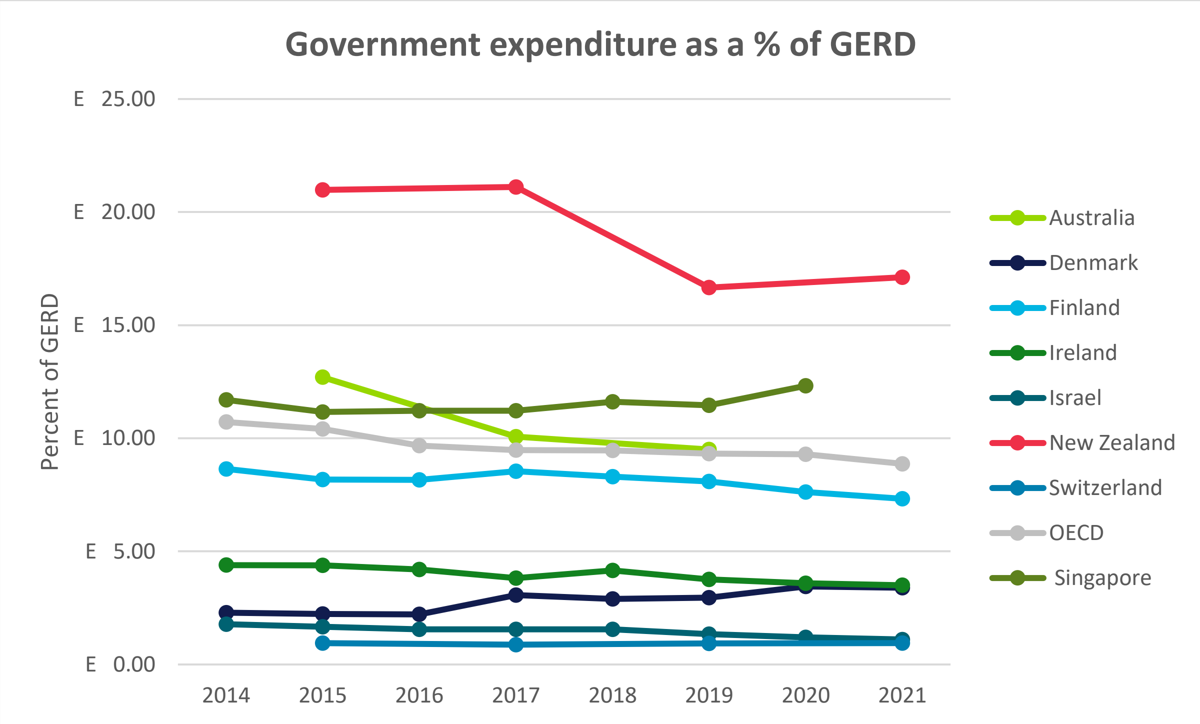


Figure 5: Government expenditure on R&D as a per cent of Government Expenditure on Research and Development. Data source: OECD main science and technology indicators

Our high rates of GovERD are explained by three coinciding factors, all to do with our CRI structure.

1. Our CRIs are a far larger part of our system than comparator organisations in other countries.
2. Our overall expenditure is small, meaning the 'national lab' aspect of our CRI system represents a fixed cost that constitutes a large proportion of a small total.
3. We count our CRIs as 'Government' expenditure. In many other countries, equivalents to the industry-facing CRIs are not classified as part of Government.

These outlier data are not just classification factors. They also signpost subtler underpinning differences in how our SI&T system is structured. For example, the chart below shows our CRIs undertaking basic research at much higher rates than comparator countries. This is a function of the vertically integrated model of our CRIs, which differs from the mostly applied and translational focus of national labs and technology organisations in other countries.

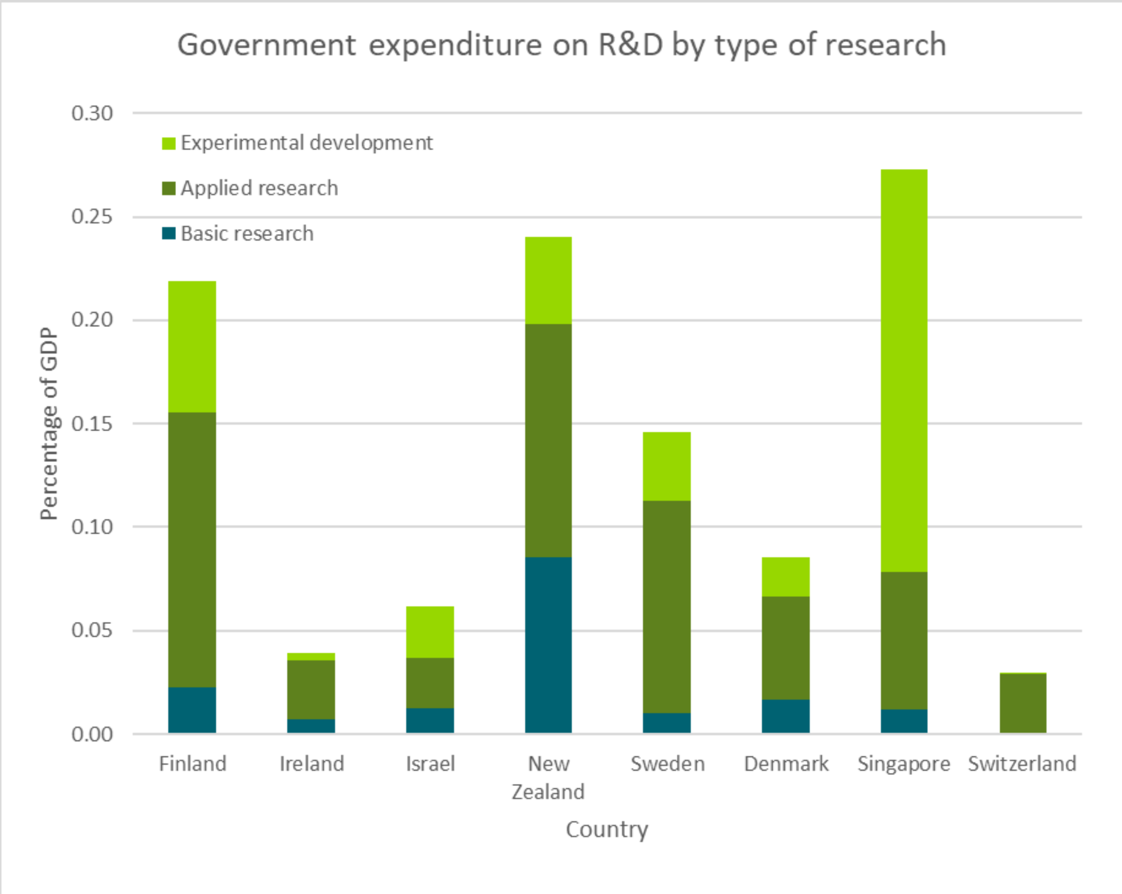


Figure 6: GOVERD as a percentage of GDP, and break down of expenditure on basic, applied and experimental research. New Zealand compared to other Small Advanced Economies. Source: OECD main science and technology indicators

Higher education expenditure on R&D

In NZ, our higher education and business sector has a roughly similar mix of basic, applied and experimental research as comparator countries, illustrated in Figures 4 and 8.

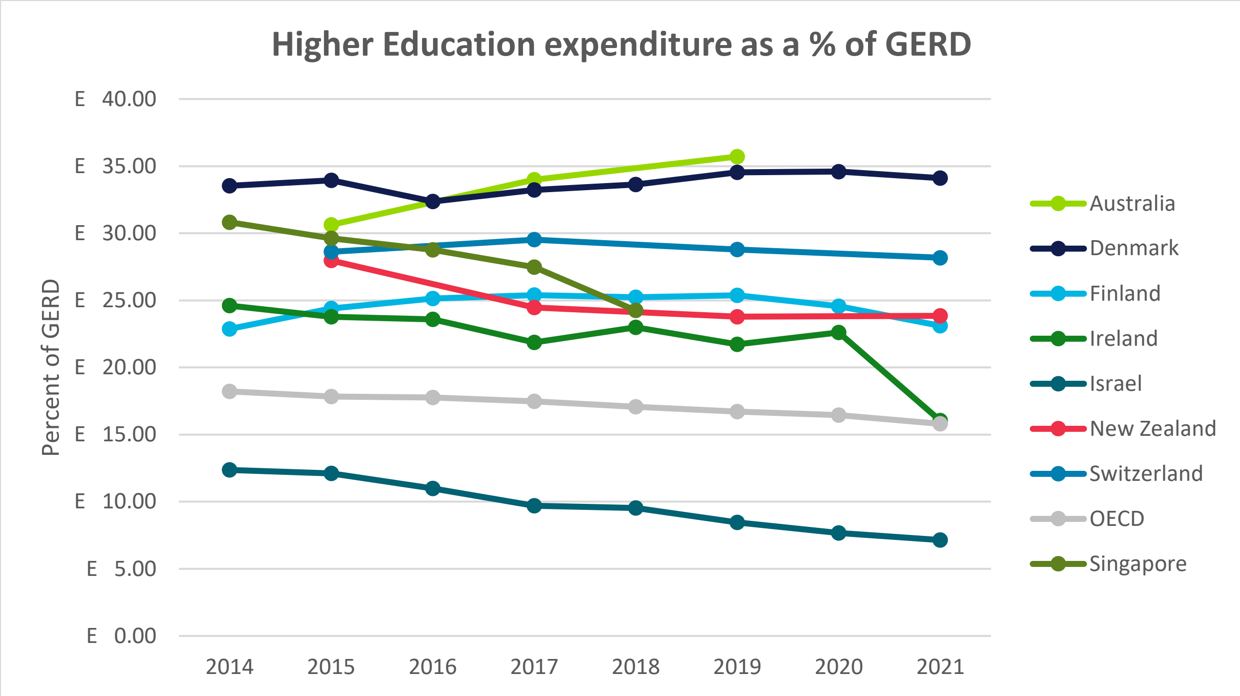


Figure 7: Higher education expenditure as a percentage of GERD. Data source: OECD main science and technology indicators

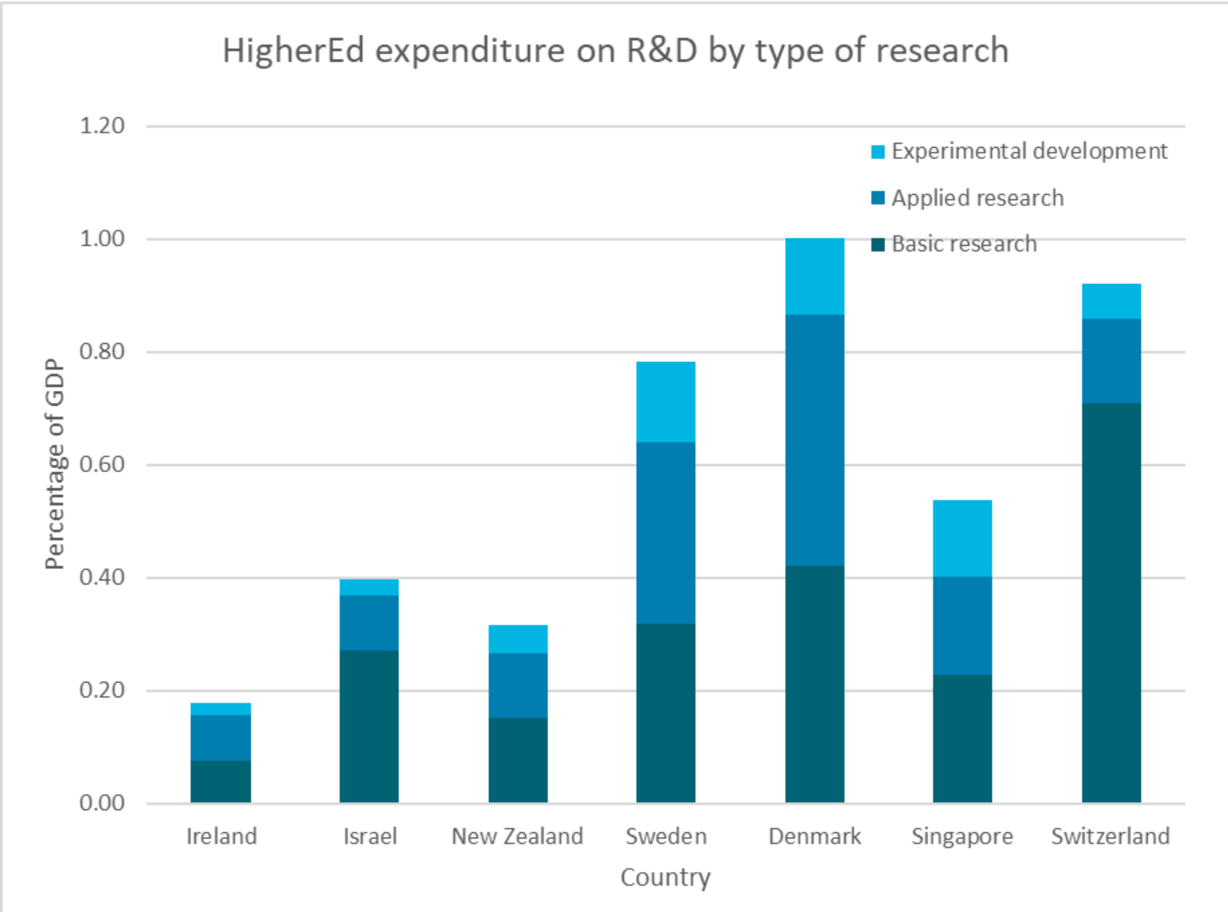


Figure 8: Comparative HERD as a percentage of GDP, and breakdown of expenditure on basic, applied and experimental research.

Real government funding for R&D

The chart below disaggregates government expenditure into funding for business (BERD) and funding for public research organisations (GOVERD and HERD).

Real government funding for R&D has declined over the past two years, and funding for research in public research institutions (eg universities and CRIs) is now lower than it was in the 2016/17 financial year. This is placing significant pressure on the financial viability of research organisations, and some CRIs, in particular.

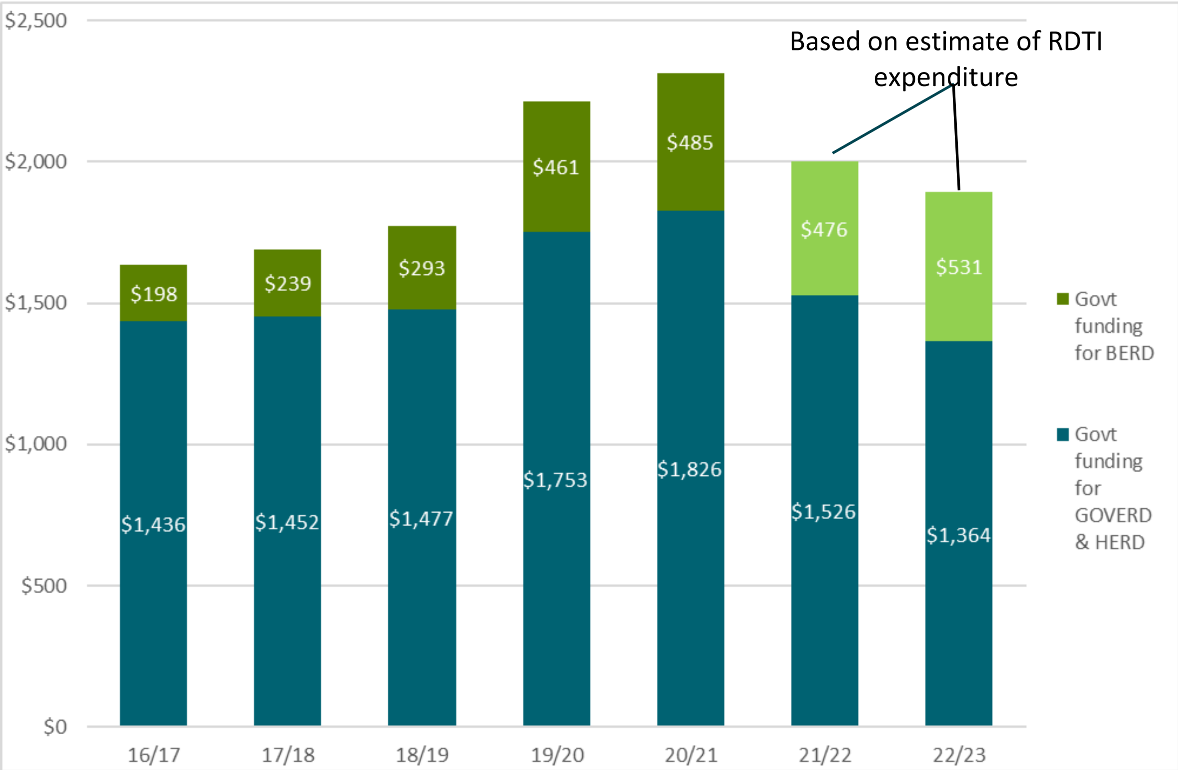


Figure 9: Real government funding for R&D (2023 dollars, $m) Source: MBIE analysis based on appropriations data.

R&D expenditure by sector and purpose of research

Expenditure on R&D can also be disaggregated by the purpose of research, shown in figure 10, below.

At a high level, Government expenditure is heavily focused on the environment and primary industries, with business undertaking the bulk of manufacturing and ICT research. Given the division of basic, applied and experimental activity noted in the charts above, a reasonable conclusion is that little fundamental research is taking place in advanced technologies and areas of future economic advantage, whereas much government attention is devoted to traditional primary industry and environmental research topics.

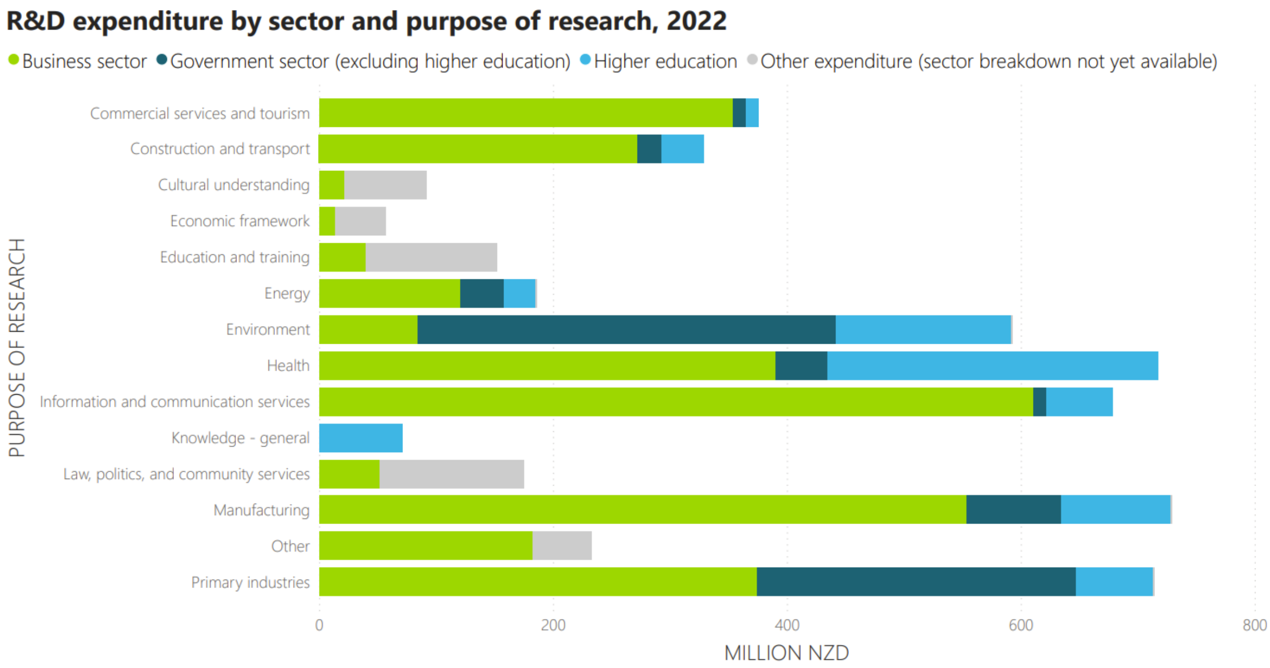


Figure 10: R&D expenditure by sector and purpose for 2022. Note the grey bars indicate that there is data, but it is not attributable to a particular sector. Data source Stats NZ research and development survey

In New Zealand, Government R&D expenditure is mainly directed towards health, environment, primary industries and manufacturing (noting that manufacturing includes the processing of primary products eg food processing). These areas accounted for about 84 per cent of all government expenditure on R&D in 2022.

Business R&D expenditure in 2022 was targeted towards information and communication services, manufacturing, primary industries, health and commercial services and tourism. This accounted for 74 per cent of overall business R&D expenditure.

Higher education R&D expenditure in 2022 was focussed on health, general knowledge, the environment, manufacturing, and primary industries. These areas comprised 53 per cent of all higher education expenditure on R&D in 2022.

In 2022, 60 per cent of all R&D expenditure of benefit to the environment was government funded. In the same year, the business sector undertook most of the R&D for commercial services and tourism (94%), information and communication services (90%), and construction and transport (83%).

Government's science funding mechanisms

Government funding mechanisms aim to provide different types of support to different types of research activity.

Stable, long-term institutional or negotiated funding is important to build and grow teams and make significant progress on big challenges and problems. Competitive funding creates dynamism and the opportunity for new ideas, although it can conversely create a conservative risk-averse culture where established researchers and mature research topics are more likely to be successful.

Government funds in New Zealand are generally classified by who determines the focus of the research:

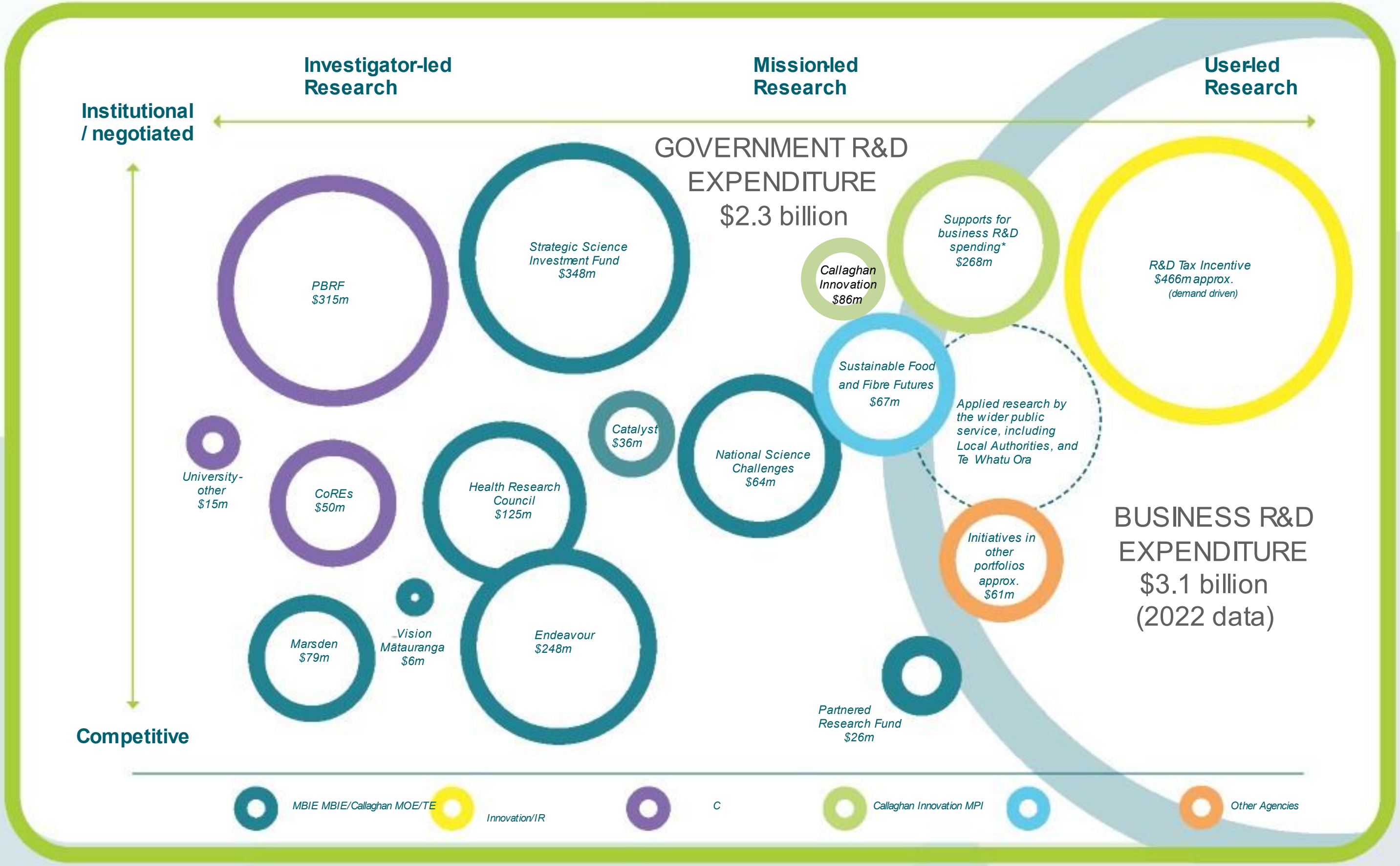
- Investigator-led: where researchers instigate and define the scope of their research based on their own expertise. It enables new ideas and opportunities that are not currently prioritised by government or business. It can cover both basic and applied research.
- Mission-led: where researchers respond to the goals, direction, and priorities of those not involved in the project. Missions are typically set by governments to develop responses to national needs or opportunities – so the National Research Priorities would be considered mission-led.
- User-led: where end-users initiate and fund research to meet their specific needs. It includes business funded R&D programmes and applied research funded by government agencies or other entities.

An alternative approach to classifying researching funding into contestable versus institutional funding. While many funds do not neatly fit into this categorisation, government SI&T funding in New Zealand can be split roughly 50/50 between the two categories. This places New Zealand amongst the more competitively-oriented countries (similar to Finland and Israel), but below the most competitive countries, the USA and Ireland, where more than 60 per cent of government R&D funding is awarded through competitions. The median split across a sample of OECD countries is 35/65 competitive versus institutional.

Figure 11, below, presents a broad classification of research funding types and sizes, coloured by source of funding (government department, with the exception of Business R&D – the large grey circle at the right of the diagram).

Note that this diagram only focuses on large investments; there are many other smaller investments across different funders.

Science Investment based on 2023/24 Financial Year



Dollar amounts represent appropriations used in the GBOARD calculation
GBOARD = Government Budget outlays and appropriations on R+D. Business R+D Expenditure from Business R+D survey.
** delivered by Callaghan Innovations, including R&D grants, services and repayable loans*

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Below are brief descriptions of New Zealand's main funding mechanisms.

Research and Development Tax Incentive

The RDTI (estimated to cost $466 million in 2023/24) is government's main initiative to incentivise increased business investment in R&D and encourage more New Zealand businesses to undertake R&D. Delivering the incentive through the tax system has the benefit of being broad-based (all businesses undertaking eligible R&D can access it) and rules-based (providing businesses with certainty).

Strategic Science Investment Fund

The Strategic Science Investment Fund (SSIF) ($348 million) supports longer-term underpinning infrastructure and programmes for mission-led science. An SSIF Investment Plan sets out what the Government is seeking from SSIF investments. Just under $200m of SSIF programmes are tied to specific CRIs and their respective missions. Others fund specific research areas across organisations, for example, Antarctic research, and genomics research. The infrastructure category of the appropriation funds large scale research infrastructure, such as the research vessel Tangaroa.

National Science Challenges

The National Science Challenges (NSCs) ($64 million) were established in 2014 and are a set of eleven mission-led research programmes which aim to address issues of national significance to New Zealand over ten years. The NSCs are due to conclude at the end of their contracts in mid-2024.

Endeavour Fund

The Endeavour Fund ($248 million) is the Government's main competitive, mission-led science investment, designed to allocate funding to support research, science or technology that has the potential to positively transform New Zealand's economic performance and the sustainability and integrity of our environment, help strengthen our society, and to give effect to the Vision Mātauranga policy.

Health Research Council

The Health Research Council (HRC – $125 million) is responsible for the majority of funding decisions in health research. The HRC is the technical responsibility of the Minister of Health, but most of its funding is the responsibility of the Minister of Science, Innovation and Technology.

The Council funds both investigator-led and mission-led research. Most funding is awarded through its annual contestable Project (short term) and Programme (longer term) grants and through investment streams aligned with key Government priorities.

Marsden Fund

The Marsden Fund ($79 million) is the Government's major investigator-led research contestable fund. Decisions on grants are made by the Marsden Council. The Marsden Fund is administered by the Royal Society Te Apārangi on behalf of MBIE.

Catalyst Fund

The Government directly invests in international science partnerships through the Catalyst Fund ($36 million). The Fund supports activities that initiate, develop and foster collaborations leveraging international science and innovation for New Zealand's benefit. MBIE is the decision-maker for the Catalyst Fund.

Centres of Research Excellence

The Centres of Research Excellence (CoREs) Fund ($50 million) was established in 2001 to encourage the development of excellent tertiary education-based research that is collaborative, strategically focused and creates significant knowledge transfer activities. CoREs are inter-university research networks, with researchers working together on commonly agreed work programmes.

Funding from the CoREs Fund is determined through a fully contestable process. CoREs are the responsibility of the Ministry of Education and the Tertiary Education Commission (TEC), however the Royal Society Te Apārangi has administered previous funding rounds on behalf of the TEC.

Performance Based Research Fund

The Performance-Based Research Fund ($315 million) funds universities and other tertiary education organisations and is the responsibility of the Minister of Education. The fund is intended to achieve an increase in, or maintain the quality of, research and research-based teaching and learning and to improve investment in research within the tertiary sector.

While the total value of the fund has not changed since 2018, the distribution of funding between higher education organisations varies depending on the research activities of organisations (number and quality of research-active staff, research-degree completions and external research income). Higher education organisations are largely able to use the funding as they see fit, supporting both research and non-research activities.

Section 5: New Zealand's SI&T workforce

In 2022 the New Zealand research and development workforce totalled around 68,000 staff (incl. researchers, students and associated staff), equal to around 40,000 FTE, employed by around 4,000 R&D businesses (with more reporting innovation), eight universities, seven CRIs, and many independent research organisations, business accelerators and incubators, and other support functions.

The data we present in this section the widely-used OECD Frascati manual (2015) definition of R&D personnel, which includes personnel directly involved in:

- Performing scientific and technical work for an R&D project
- Planning and managing R&D projects
- Preparing reports for R&D projects
- Providing services (eg dedicated computing or library services) for R&D projects
- Providing support for the administration of financial and personnel aspects of R&D projects.

This is a broader definition than researchers – professionals engaged in the conception or creation of new knowledge – and includes all staff whose work contributes to R&D in some form.

The figure below shows how the research workforce in each sector has changed over the last 12 years. The total numbers of personnel involved in R&D has increased, driven entirely by a threefold increase in the business sector workforce since 2010.

Higher education numbers have remained relatively steady apart from a dip in 2022, likely due to the impact of COVID on student numbers and other university activities.

Numbers affiliated with the government sector (primarily the CRIs) are unchanged over the same period.

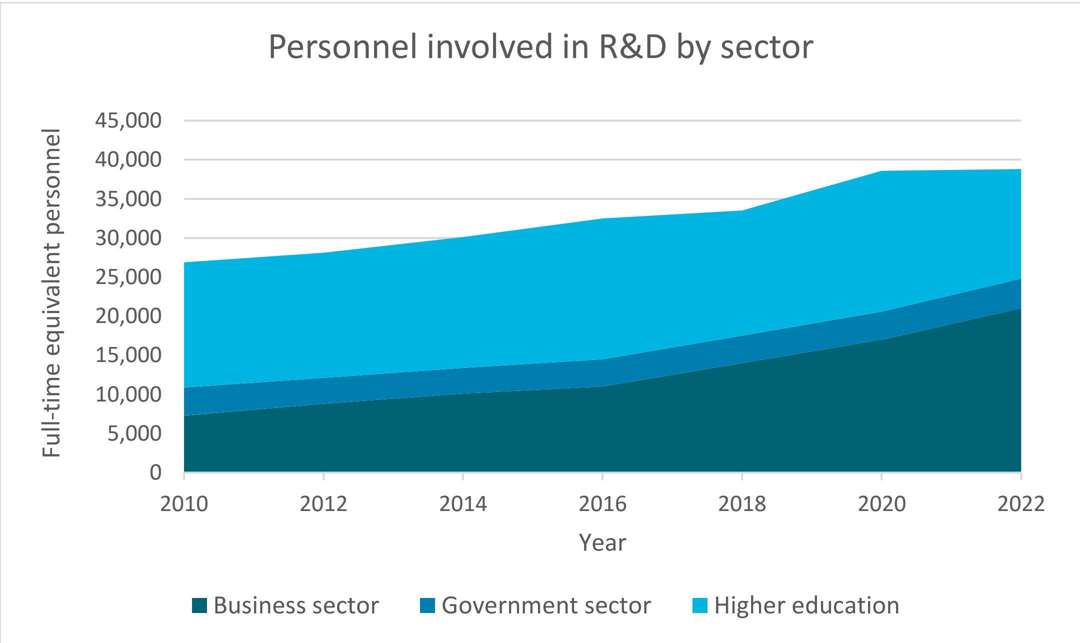

Figure12: The number of full-time equivalent personnel involved in research and development by sector. Personnel 'involved in' research and development includes researchers, research students, technicians and R&D support staff. Source StatsNZ Research and Development Survey

Table 3: Full-time equivalent personnel involved in R&D for comparator countries

	R&D Personnel (FTE equivalent)	R&D Personnel (percentage of labour force)	R&D Personnel (per $100m GDP)	R&D Personnel (per $m GERD)
Denmark	62169	2.01	16.06	7.05
Finland	56488	2.01	18.61	7.43
Ireland	38444	1.58	7.04	6.82
New Zealand	39000	1.34	15.89	12.74
Sweden	98394	1.76	15.64	5.32
Switzerland	90832	1.69	13.74	4.57
Singapore	49334	1.33	8.84	4.31

Data shown is the latest available year for each country. The table gives the total number of personnel and three different ways of normalising by country size: as a percentage of the total labour force, relative to the total size of the economy (per $100m GDP) and relative to investment in R&D (per $m GERD). Australia and Israel have not been included because the latest available OECD R&D FTE data for those countries is over a decade old. Source OECD Main Science and Technology Indicators.

Compared to other small advanced economies, New Zealand's research workforce makes up a low proportion of the overall labour force. This is to be expected, given New Zealand's comparatively low total expenditure on R&D.

However, New Zealand performs relatively well on the number of R&D personnel relative to the size of the economy (ie as a proportion of GDP), with similar R&D FTEs per $100m of GDP to high R&D investment countries like Denmark and Sweden.

The reason for this apparent discrepancy is highlighted in the final column, which shows the R&D personnel FTE as a proportion of research expenditure. New Zealand stands out significantly here as having an usually high FTE (12.74 FTE) per $million GERD.

This high number of researchers per dollar of R&D expenditure may be due to a range of factors including: New Zealand's relatively low-wage economy, low expenditure on other aspects of R&D like research infrastructure, and New Zealand's research activity being more concentrated in lower-resource intensive disciplines (eg social sciences and the humanities) than comparator countries.

Section 6: Focus and Outputs of Research

New Zealand Research by Socioeconomic Objective

The chart below shows the proportion of OECD countries that spend a particular proportion of their government investment in R&D on each socioeconomic objective. Most OECD countries spend proportionally more than New Zealand on health, energy, and industrial production & technology. New Zealand's system is focussed heavily on traditional areas of strength and interest, in particular agriculture and the environment.

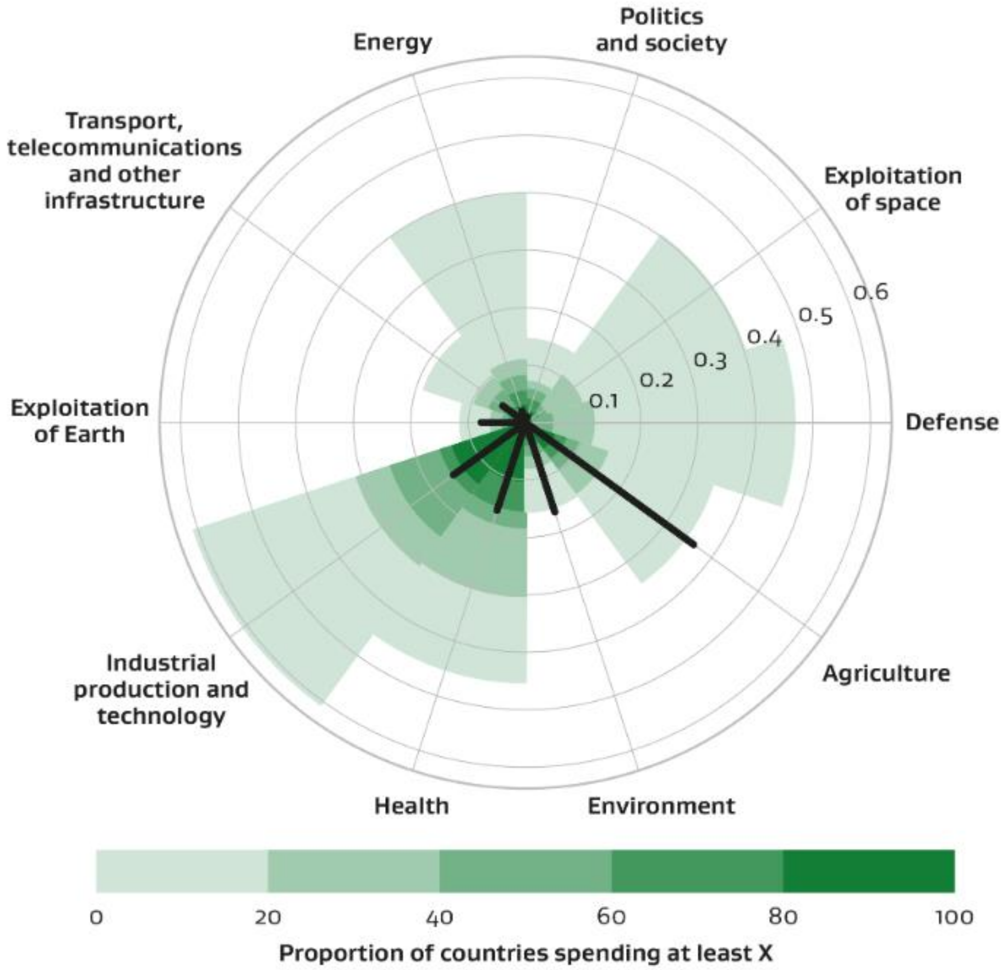

Figure 13: Fractional government budgeted appropriations on R&D by socio-economic objective 2012-2016 (OECD). Black lines represent New Zealand's proportion of expenditure; green shading shows the proportion of other countries which reach particular proportions of expenditure. Source: OECD Main Science and Technology Indicators database

Measuring NZ research excellence

Relative volume of New Zealand research by field of research

Figure 14: Volume of NZ research by field, 2013 and 2023. New Zealand largest revealed comparative advantages are in Earth Sciences, Environmental Sciences, Agricultural Sciences, Health Sciences and Biological Sciences. Data source Dimensions AI

Revealed Comparative Advantage (RCA) is a measure of a country's specialisation in a research field in a given year. An RCA of greater than 1 indicates that a country has published more than expected in a given area, relative to the world as a whole. The RCA is calculated as the ratio of two proportions: the proportion of that country's publications produced in that field and the proportion of publications produced in that field globally. For example, if 10% of France's publications were in Medical Science, compared to 5% globally in that field in 2020, France would have an RCA of 2 for Medical Science in 2020. Similarly, the Field Citation Ratio (FCR) measures the average number of citations New Zealand-authored papers received, relative to the global average for papers in the same field.

New Zealand largest revealed comparative advantages are in Earth Sciences, Environmental Sciences, Agricultural Sciences, Health Sciences and Biological Sciences. These are the areas in which our CRIs are most active. In contrast, New Zealand produces fewer publications than the world average in Engineering and the Chemical, Mathematical and Physical Sciences.

The relative quality of New Zealand publications (measured by the FCR) declined from 2.6 to 2.1 between 2013 and 2022 but remains twice the world average (FCR 1, by definition). This decline is seen across most advanced economies, and can be largely attributed of the rapid growth in the contributions of east Asian countries, particularly China, to total global research output. New Zealand is not producing fewer high-quality papers, however the *share* of high-quality outputs is declining as the quality of research from China has improved. In 2023, physical sciences (FCR 3.05) and commerce, management, tourism and services (FCR 3.10) were the fields with the highest FCRs.

Figure 15: Quality of NZ research by field for 2013 and 2022. Data source Dimensions AI

Proportion of New Zealand-based publications in the top 1% of world research, by field

The quality of research in New Zealand has been improving for the last two decades, based on the proportion of publications in the top 1 per cent worldwide by field of research. If a country's research is of 'average' quality relative to the rest of the world, we would expect 1 per cent of its research papers to be amongst the most cited 1 per cent of papers globally.

In 2022, 2.9 per cent of New Zealand-affiliated publications were in the top 1 per cent of most cited publications globally. This was an increase from 2.0 per cent in 2010.

The highest volume of publications in the top 1 per cent of most cited publications were in the fields of Commerce, Management, Tourism and services (5.5%), Law and legal studies (4.7%), and Economics (4.5%).

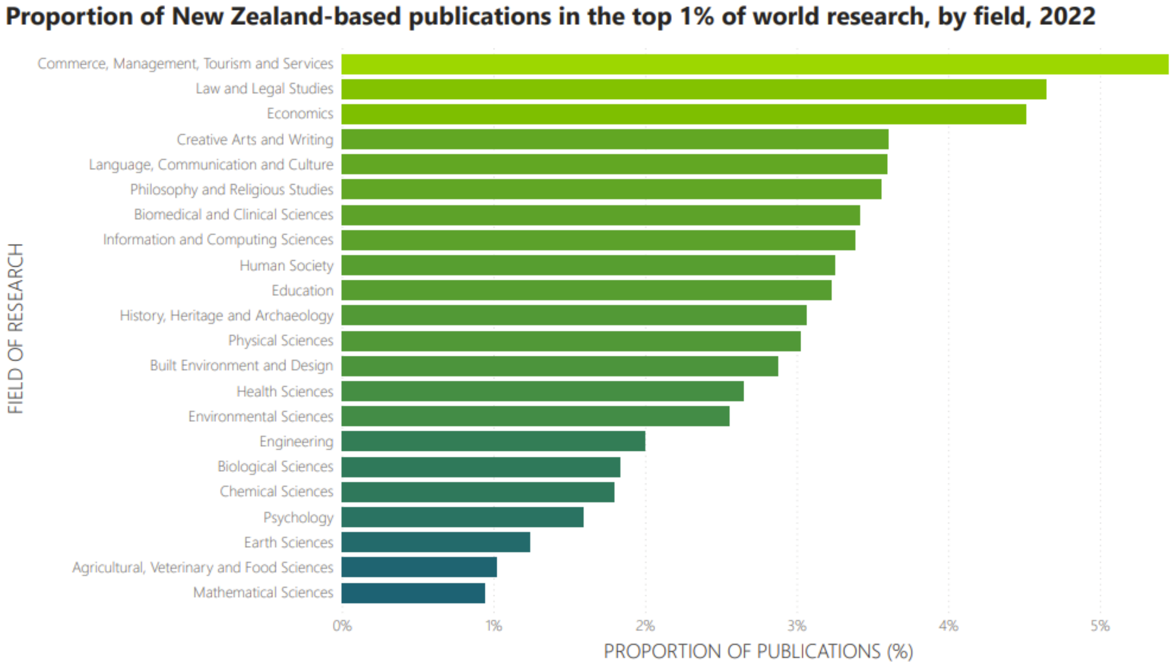

Figure 16: Proportion of New Zealand-based publications in the top 1% of world research, by field, 2022. Data source Dimensions AI

Proportion of publications with international co-authorship

Connectivity with international researchers is essential for growing both the quality and impact of New Zealand research. Publications with international co-authorship are cited more frequently.

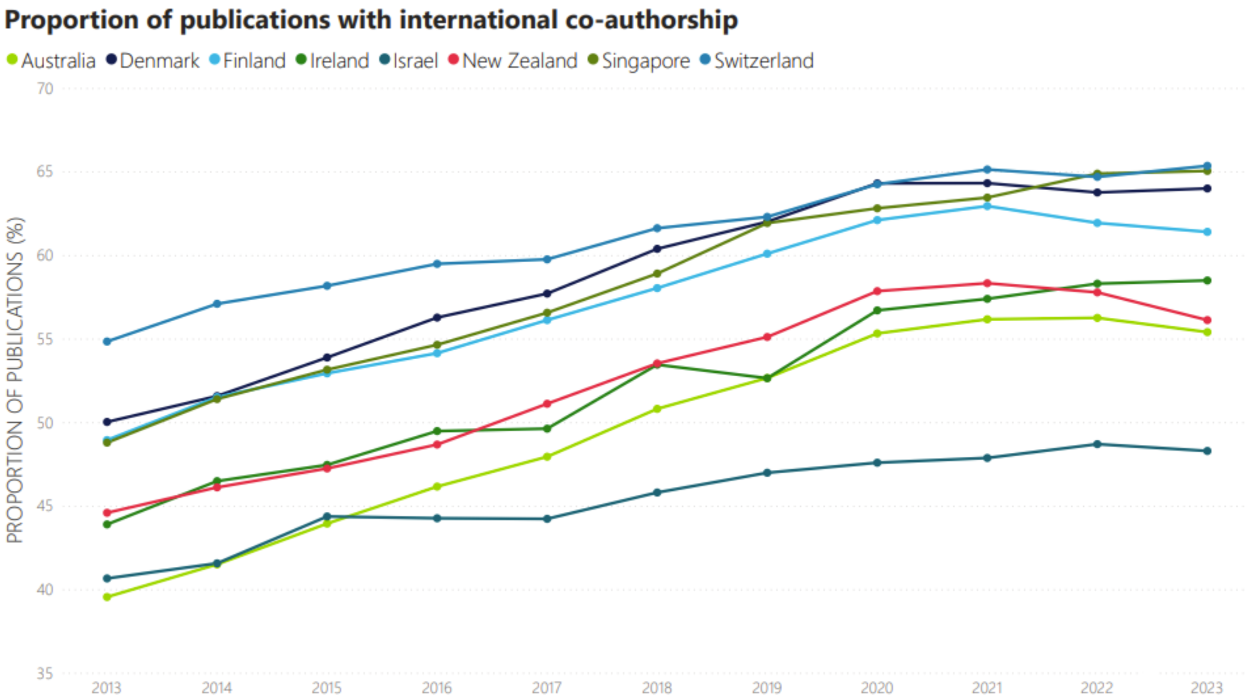

Figure 17: Proportion of NZ publications with international co-authorship compared to other small, advanced economies. Data source Dimensions AI

The proportion of publications with international collaboration is increasing across all small, advanced economies and Australia. While New Zealand generally follows a similar trend as other countries, it has dipped slightly in the last few years. In 2023, NZ had nearly 56 per cent of publications having international co-authors, up from 45 per cent in 2013.

Proportion of publications with more than one author

Co-authorship is evidence of collaborative research. Several studies have shown that collaboration between researchers is associated with higher quality research and greater citation impact.

Average co-authorship rates for New Zealand-affiliated publications increased by about 4 per cent between 2013 and 2023. Rates are broadly similar across the small advanced economies, ranging from 87 to 91 per cent in 2020. Although New Zealand (87 per cent) is near the bottom of this range, co-authorship rates have increased overall and kept up with the increases in other SAEs.

Compared to the rest of the world, there is an opportunity for New Zealand researchers to grow connections with each other and with international partners. Building these connections provides a way for researchers to share knowledge and expertise, which can result in higher quality publications.

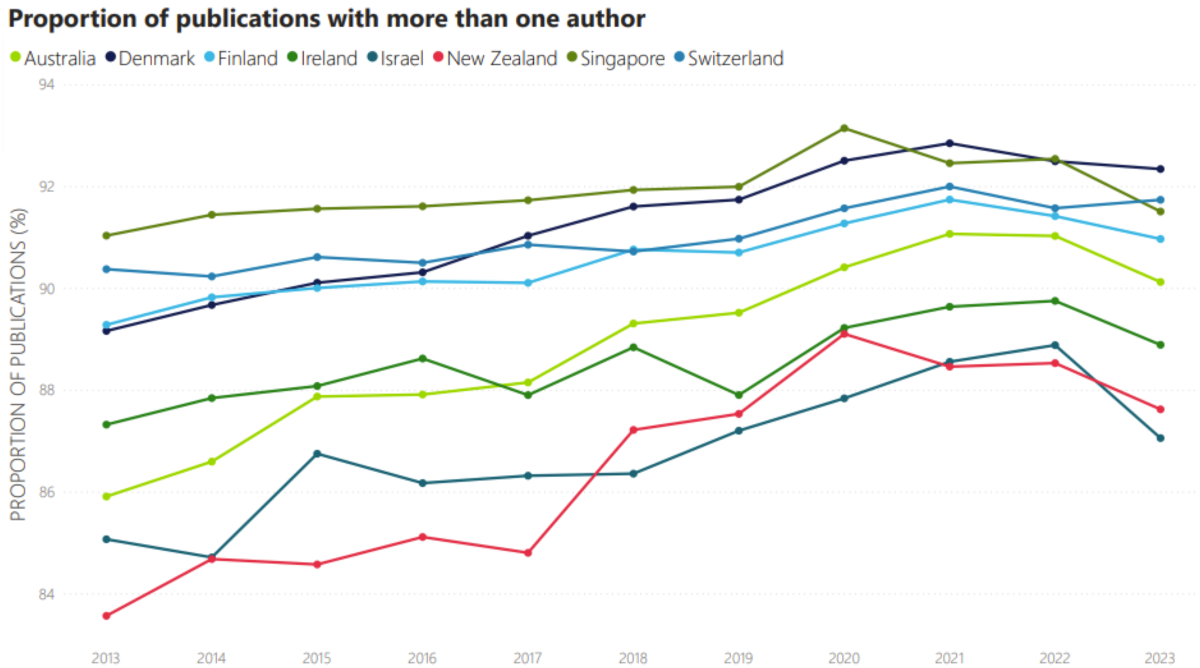

Figure 18: Proportion of NZ publications with more than one author compared to other small, advanced economies. Data source Dimensions AI

Proportion of publications with more than one author by field

More than 85 per cent of publications in the following fields have multiple authors: Physical Sciences, Chemical Sciences, Health Sciences, Biomedical and Clinical sciences, Information and Computing Sciences, Environmental Sciences, Earth Sciences, Biological Sciences, Agriculture, Veterinary & Food Sciences, Psychology, and Engineering.

Collaboration is lowest in fields such as history, heritage and archaeology, creative arts and writing, law and legal studies and philosophy and religious studies.

There is a trend towards increased co-authorship in all fields of research. This is likely to reflect the increased value placed on collaboration by research institutions and funders that seek to increase the impact of their research outputs.

Proportion of publications with more than one author by field, 2023

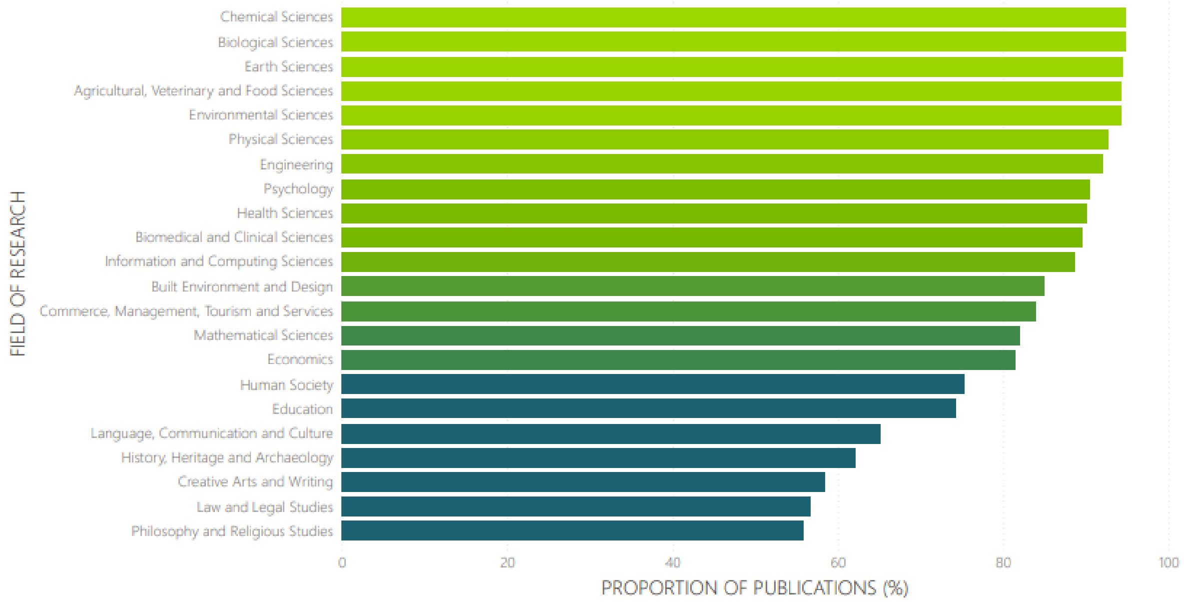

Figure 19: Proportion of publications with more than one author by field, 2023. A field of research is assigned to every publication with New Zealand-affiliated authors using the Australian and New Zealand Standard Research Classification. Data source Dimensions AI

Section 7: Commercialisation and public research organisation – industry collaboration

Commercialisation outcomes

There are relatively limited data on international comparisons of commercialisation outcomes from public research. New Zealand ranks (27th) on the Global Innovation Index, below the other Small Advanced Economies, with only Israel (14th) and Ireland (22nd) outside the top 10. Australia comes in at 24th.

Our best available data on commercialisation comes from the Knowledge Commercialisation Australasia 'Survey of Commercialisation Outcomes from Public Research' which provides recent data on 11 New Zealand research organisations (7 universities and 4 CRIs).

Table 4: Commercialisation metrics for New Zealand, based on data from 7 universities and 4 CRIs. Data source: Knowledge Commercialisation Australasia | Survey of Commercialisation Outcomes from Public Research

Measure	2020 Values	2022 Values
Research commercialisation staff (FTE)	108	78
Invention Disclosures	539	303
New patent families	79	36
New non-patented IP	43	42
New licenses, options and assignments	113	97
Commercialisation revenue	$147M	$155M
Active spinouts and start-ups	88	113
Value of research contracts with firms	$559M	$178M

The Global Innovation Index (GII) provides data on commercialisation and innovation at an economy-wide level, but does not specifically measure economic outcomes from public research. In the GII, New Zealand scores highly on the fundamentals of our institutions, but performs less well than other Small Advanced Economies on innovation inputs and outputs including investment, innovation talent, patenting and high-tech exports.

Public – private research connectivity

There is better comparison data available on the linkages between innovative businesses and public research organisations.

New Zealand performs poorly on the proportion of innovative businesses reporting collaboration with public research organisations and the proportion of papers from large universities co-authored with an industry partner (for New Zealand, this covers all universities except Lincoln).

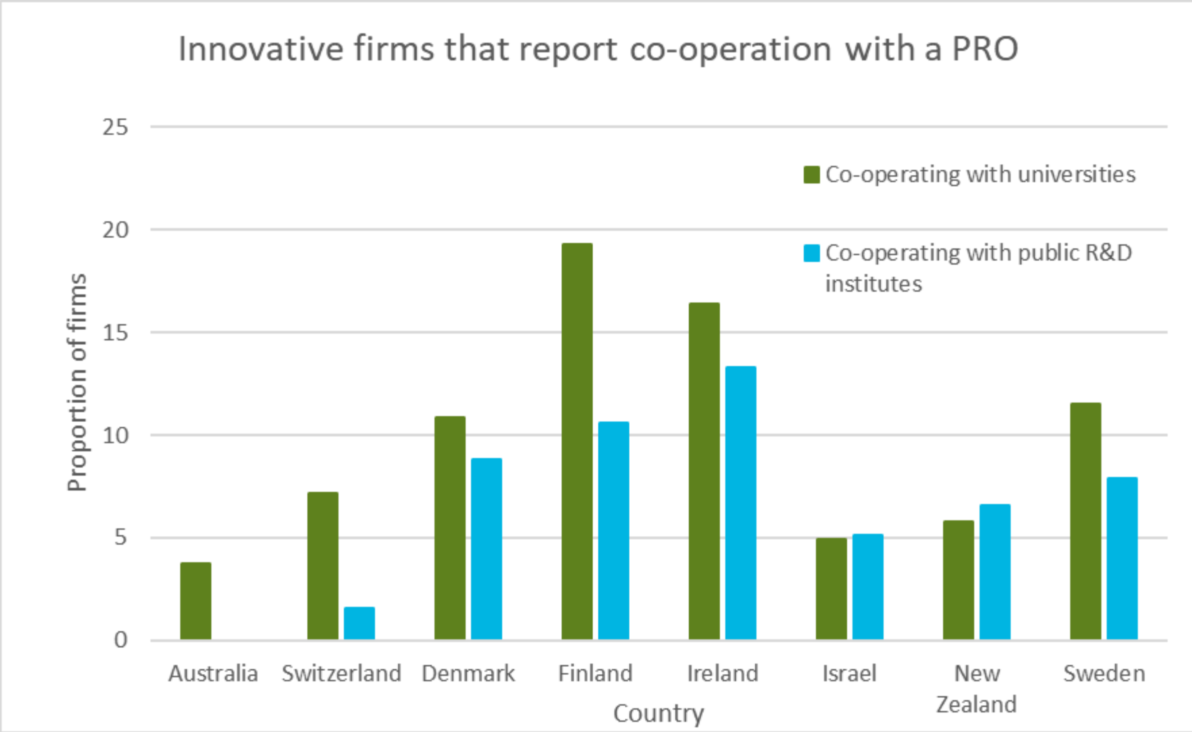

Figure 20: Proportion of innovating firms that reported co-operation with a public research organisation in the period 2018-2021. Data Source OECD | Business innovation statistics and indicators

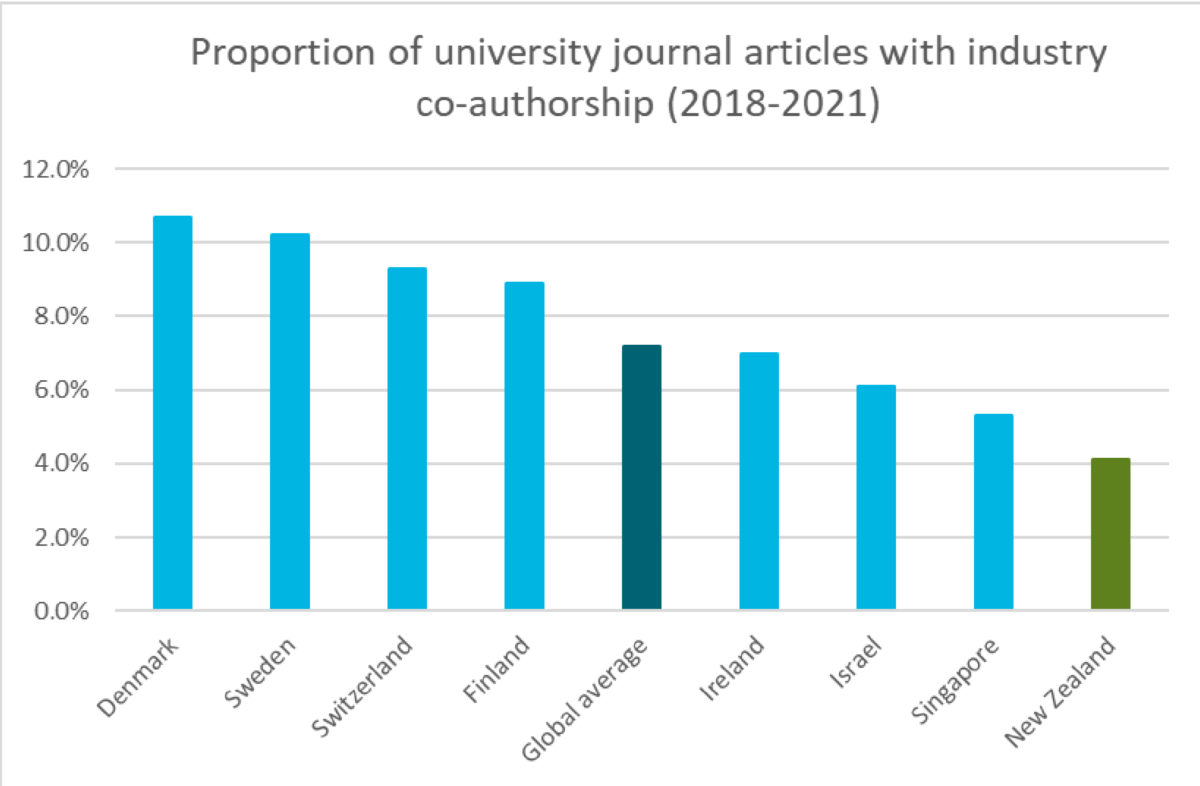

Figure 21: Proportion of journal articles from major universities (2018-2021) with an industry co-author. For New Zealand, the sample includes all universities except Lincoln University. Data Source: Leiden Centre for Technology Studies (CWTS) | Leiden Ranking Open Edition

New Zealand businesses provide an unusually high proportion of funding for R&D conducted by government, likely reflecting the strong commercial focus of some CRIs. The proportion of university R&D funded by business is similar to that in comparator countries.

Compared to comparator countries, New Zealand businesses are under-represented in a ranking of business R&D expenditure. This reflects the relatively small number of large, multinational firms based in New Zealand.

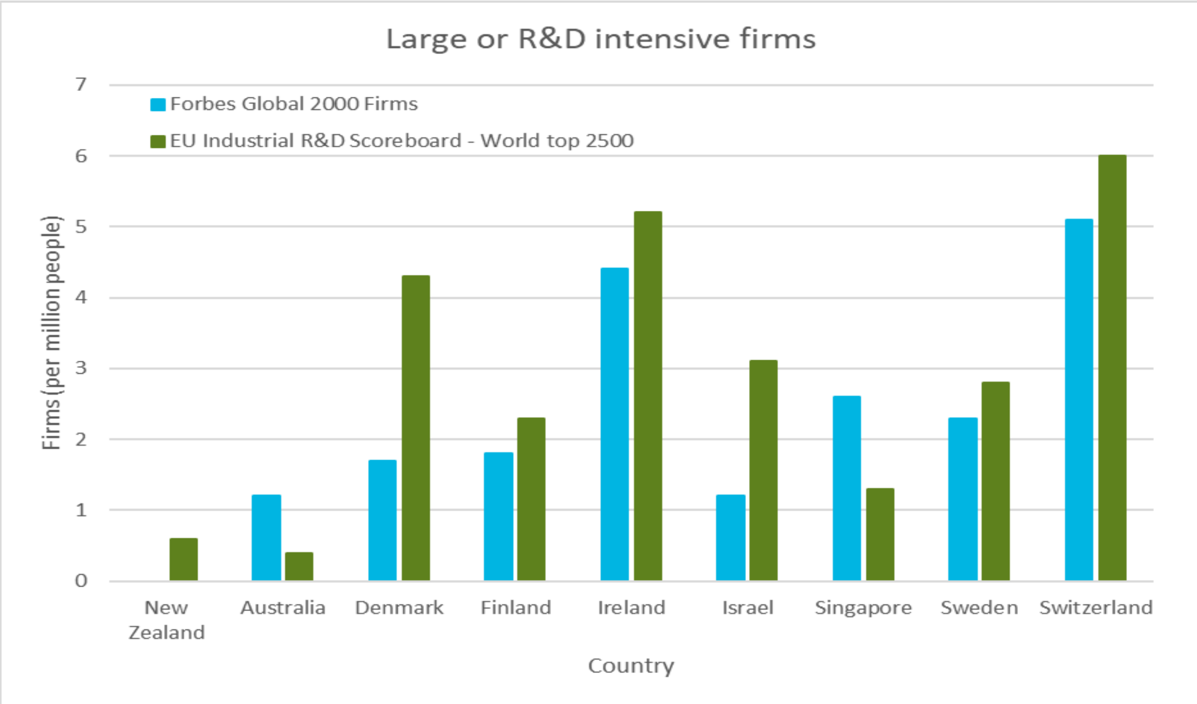

Figure 22: Number of large or high R&D investment firms per million people in New Zealand and other small advanced economy countries. Data Source Forbes | Global 2000 Ranking of large companies, and European Commission | The 2023 EU Industrial R&D Investment Scoreboard

Section 8: Research infrastructure

New Zealand is unusual in not having large-scale centralised funding for research infrastructure. Instead, CRIs and Universities are expected to make provision for their own research infrastructure from their operating funding and balance sheets.

Despite this, Government has invested directly in a limited number of research infrastructures, shown in the table below. Given the lack of overall policy on research infrastructure, these have tended to be ad-hoc investments made under particular economic or political circumstances, rather than part of a broader strategic approach to infrastructure investment.

Table 7: MBIE Infrastructure investment details. Note funding is GST exclusive

Infrastructure	Description	Start date	Current End date	2023/24 commitment	Total whole of life funding to end of current contract
Australian Synchrotron	Supports NZ Scientists' access to the Australian Synchrotron	31 July 2013	30 Sept 2026	$1.222 million	$18.9 million AUD$6million
Genomics Aotearoa	A collaborative research platform focussed on ensure that New Zealand is internationally participating in and leading the rapidly developing fields of genomics and bioinformatics	22 Sept 2017	31 Dec 2024	$5.0 million	$35 million
Enhanced Geohazard Monitoring Centre (24/7) (now called the National Geohazards Monitoring Centre (NGMC))	Supports GeoNet to provide faster, more accurate and available science advice and warnings for major geological events	1 July 2022	30 June 2027	$6.0 million	$30.0 million
Global Biodiversity Information Facility (GBIF)	An international network and data infrastructure for biodiversity data funded by governments	5 Dec 2019	13 Dec 2023	$0.06 million	$0.18 million

Infrastructure	Description	Start date	Current End date	2023/24 commitment	Total whole of life funding to end of current contract
MethaneSAT LLC USA	A set of functional capabilities for the command, control and support of the MethaneSAT satellite and future satellite missions for New Zealand. MethaneSAT launched in March 2024. Note: Currently under variation to extend end date to 28 Feb 2025	1 Dec 2020	15 Mar 2024	$4.5 million	$6.0 million
Mission Operation Control Centre (MOCC) Host – University of Auckland		1 June 2021	31 May 2028	$0.75 million	$3.35 million committed up to March 2024
Mission Operations Control Centre and Support – Rocket Lab		1 Sept 2020	31 Mar 2024	$1.62 million	$11.768 million
Nationally Significant Collections and Databases	26 collections and databases identified in 1992 and funded on the basis that they are critical for New Zealand science to deliver benefit, with multiple users and beneficiaries.	1 July 2017	30 June 2027	$22.07 million	$202.7 million
New Zealand eScience Infrastructure (NeSI)	Provides High Performance Computing and support systems to enable the country's researchers. Note: Future investment under consideration	1 Dec 2014	30 June 2024	$7.180 million	$67.839million (exc GST)
Rakeiora Precision Medicine Pathfinder *(contracted through Genomics Aotearoa)*	Funding to test options to acquire, protect, use and store genomic datasets for healthcare research in New Zealand.	30 Sept 2019	31 Mar 2023	$0 *All funding has been paid.*	$4.75 million
Research Education Advanced Network New Zealand (REANNZ)	New Zealand's high-capacity, ultra-high-speed national research and education network (NREN).	22 Sept 2017	30 June 2024	$6.25 million	$39.2 million

Infrastructure	Description	Start date	Current End date	2023/24 commitment	Total whole of life funding to end of current contract
Research Vessel (RV) Tangaroa	Supports NZ researchers' use of the dedicated research vessel by funding an agreed number of sea days per year and an Antarctic Voyage every second year.	1 October 2012	30 June 2027	$9.138 million	$108 million
Kitmap Tool (at contracting stage)	Callaghan Innovation will develop a pilot version of an online, searchable, database of research 'kit' (eg instruments, equipment, laboratories)	tbc	30 June 2024	$0.2 million (planned investment)	$0.2 million

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