MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
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SCIENCE SYSTEM ADVISORY GROUP

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TITLE	Overview of areas of New Zealand's research activity		
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PURPOSE	To provide an overview of research activity in New Zealand's science, innovation and technology system, including examples of organisational research specialisation data that can be produced.		

Overview of areas of New Zealand's research activity

EXECUTIVE SUMMARY

The research activity within New Zealand's universities and Crown Research Institutes (CRI) shows an uneven distribution across disciplines. There is research specialisation within CRIs aligned with their sectors, while the universities have a much wider breath of research activities.

It is important to recognise that even where there is strong activity within a field of research, at higher specialisation, areas of lower activity can be identified showing coverage is not comprehensive. Conversely, where there is comparatively low activity in a field of research, there can be areas of research activity at higher specialisation, internationally recognised as an area of research strength.

INTRODUCTION

In this paper we provide an overview of the research activity in New Zealand. A number of different metrics are presented to illustrate research activity, with the intent to demonstrate the type of data that is available and showcase research specialisation in New Zealand with a breakdown across CRIs and universities. The world ranking of NZ universities is also included as it broadly shows the areas of research strength.

RESEARCH ACTIVITY IN THE NZ SCIENCE, INNOVATION AND TECHNOLOGY (SI&T) SYSTEM

New Zealand researchers continue to be active in a wide range of existing and emerging research fields. Outputs, such as research publications, record and communicate new knowledge generated through research. By tracking these outputs, the quality and efficiency of New Zealand's research system and its strengths can be identified.

How do we understand our areas of RSI activity?

There are different ways of measuring how well New Zealand's SI&T system performs, however, there are few systematic and fully objective metrics that clearly identify what we are good at, where the gaps are, or major areas of opportunity for investment. The metrics that do exist are often incomplete and have different ways of sectorising the research system which do not necessarily align with Government priorities; we also often rely on international measures that are not always fit-for-purpose.

REPORTS ON THE SI&T SYSTEM

A brief snapshot report was provided in the 2018 Research, Science and Innovation System Performance Report which showed that New Zealand has a relatively small, but highly productive, system in terms of academic publishing metrics. Compared with OECD averages, New Zealand outperforms in publications of researchers per year; publications per higher education and Government expenditure; and publications in the top 1 per cent of most-cited journals worldwide. Among the small, advanced economies, we rank high by these metrics.

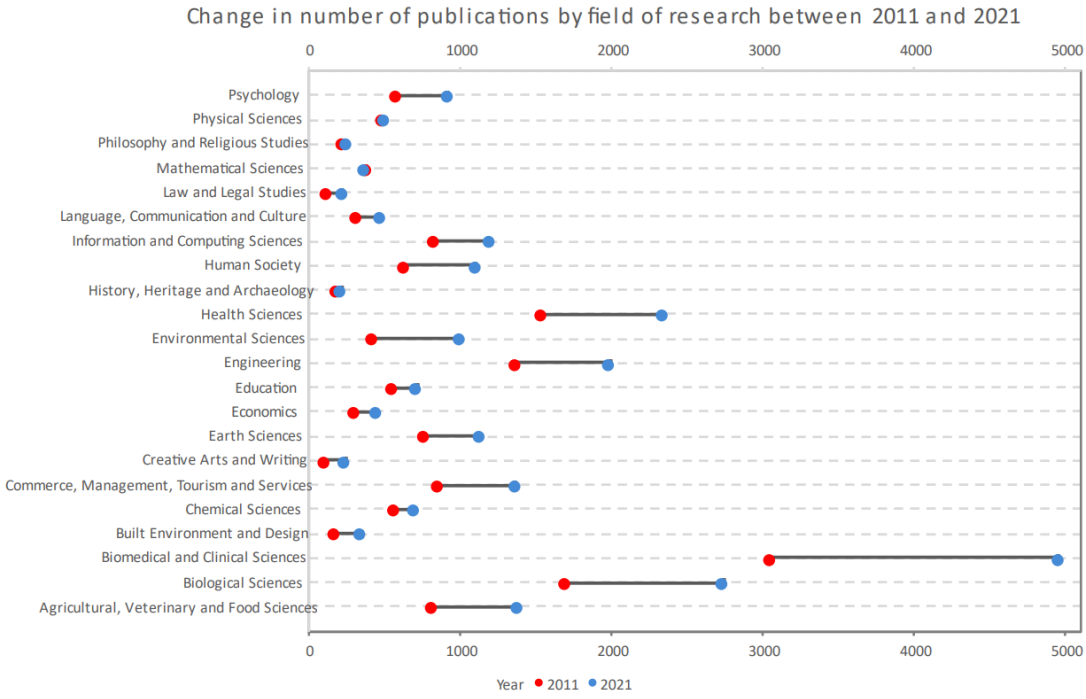
The most recent report, in 2021, is Te Pūrongo, Rangahau Pūtaiao me te Auahatanga/The Research, Science and Innovation Report — 2021[1] has more detail and narrative. This report can be used as a resource for those who want to know more about the system and its performance.

The following is a summary of these reports to explain what these different metrics can tell us in different dimensions of areas of activity (by volume of publications, by number of researchers, by sector investment).

By volume of publications

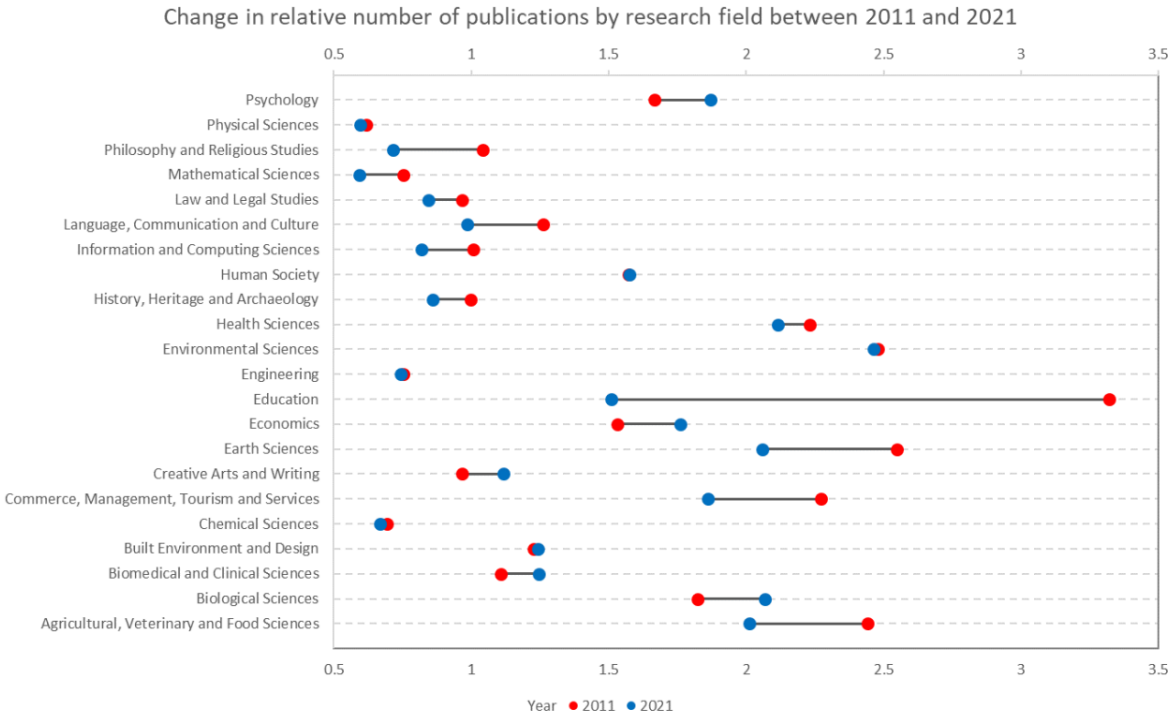
An approach to assessing strength of research areas is to use the volume of either input (funding) or output (usually research publications). This does not provide an assessment of quality or a direct measurement of the overall benefit to New Zealanders. However, the following figures provide some insights into the scale and focus of New Zealand's research.

Figure 1 Change in number of publications by ANZSRC Field of Research (FOR) between 2011 and 2021. The publication rate is dominated by biomedical and clinical sciences, biological sciences, health sciences and engineering.



[1] research-science-and-innovation-system-performance-report-2021

Figure 2 Change in relative number of publications compared to other countries by ANZSRC Field of Research (FOR) between 2011 and 2021.



If the x-axis **Revealed Comparative Advantage** (RCA) is greater than 1, then that field is more productive relative to the average across the world. Both the RCA and the change over the previous decade provide useful insights. It shows that in general, New Zealand researchers are productive compared to their peers globally.

The high RCA (high output relative to other countries) for Earth sciences, environmental sciences, tourism services and agricultural and veterinary sciences is not surprising, given our legacy of high investment and focus on the agricultural sector and our dynamic environment which provides significant opportunities for research.

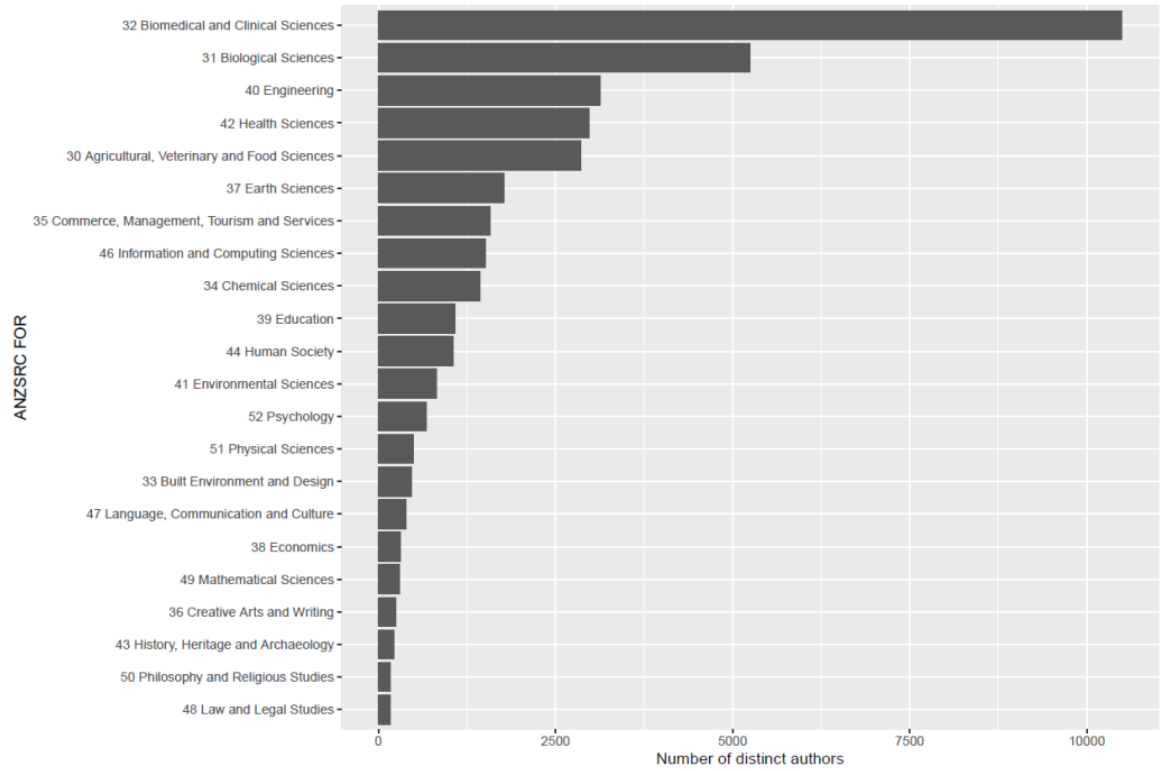
The low RCA for physical sciences, chemical sciences, mathematical sciences, and technology suggests that we don't invest as much in the underpinning sciences nor in areas close to market (technology/information & computing sciences).

It is worth emphasising **that publication output metrics will only capture research that has been released publicly.** R&D in the business sector may only be published in commercial-in-confidence reports or not published at all and so research for the business sector will necessarily be perceived as lower in this metric. This will be particularly acute for disciplines such as information technology and computing sciences and built environment and design research.

By number of researchers

A further metric for measuring what research is being done in New Zealand is to understand how many researchers are active. Although this might be considered easy to do, various ways of measuring active researchers have yielded a wide range of numbers from 18,000 to 42,000. This underlines the lack of robust data, nevertheless, the relative number of researchers is likely still valid in the figure 3.

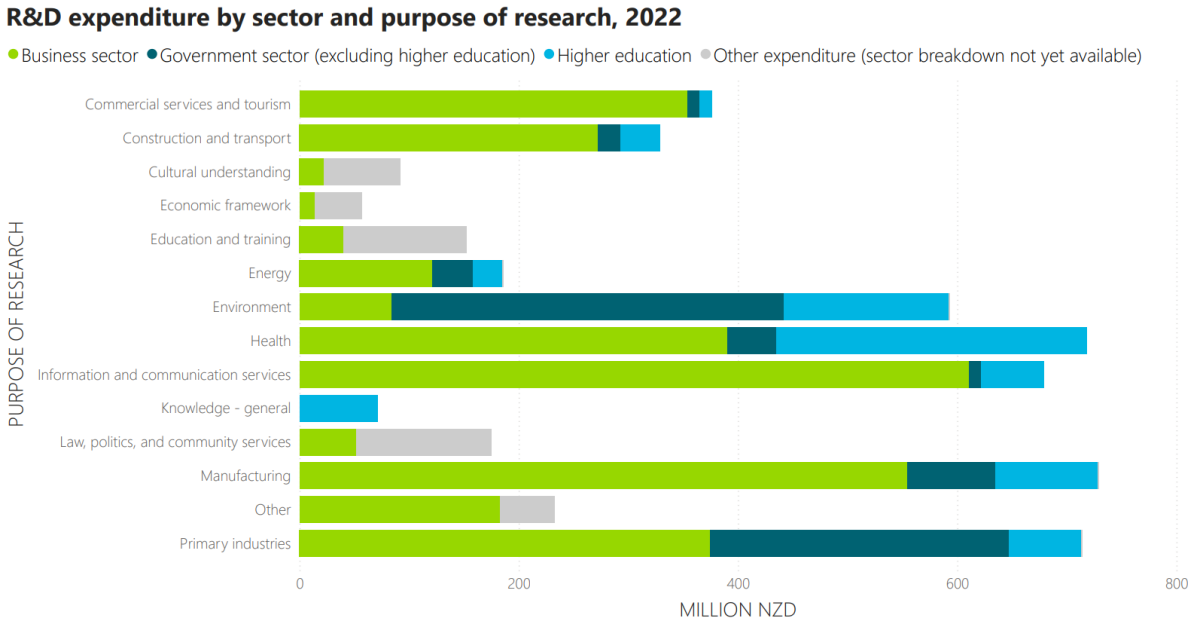
Figure 3 Numbers of unique authors publishing in each ANZSRC Field of Research from 2018-2022. Total number of researchers using this metric is ca. 37,500.



By sector investment

A different way of measuring the volume of research is to consider investment by purpose of research. This is also split by funding sector (Government, business or higher education).

Figure 4 Research investment by sector.



Data from Stats NZ research and development survey

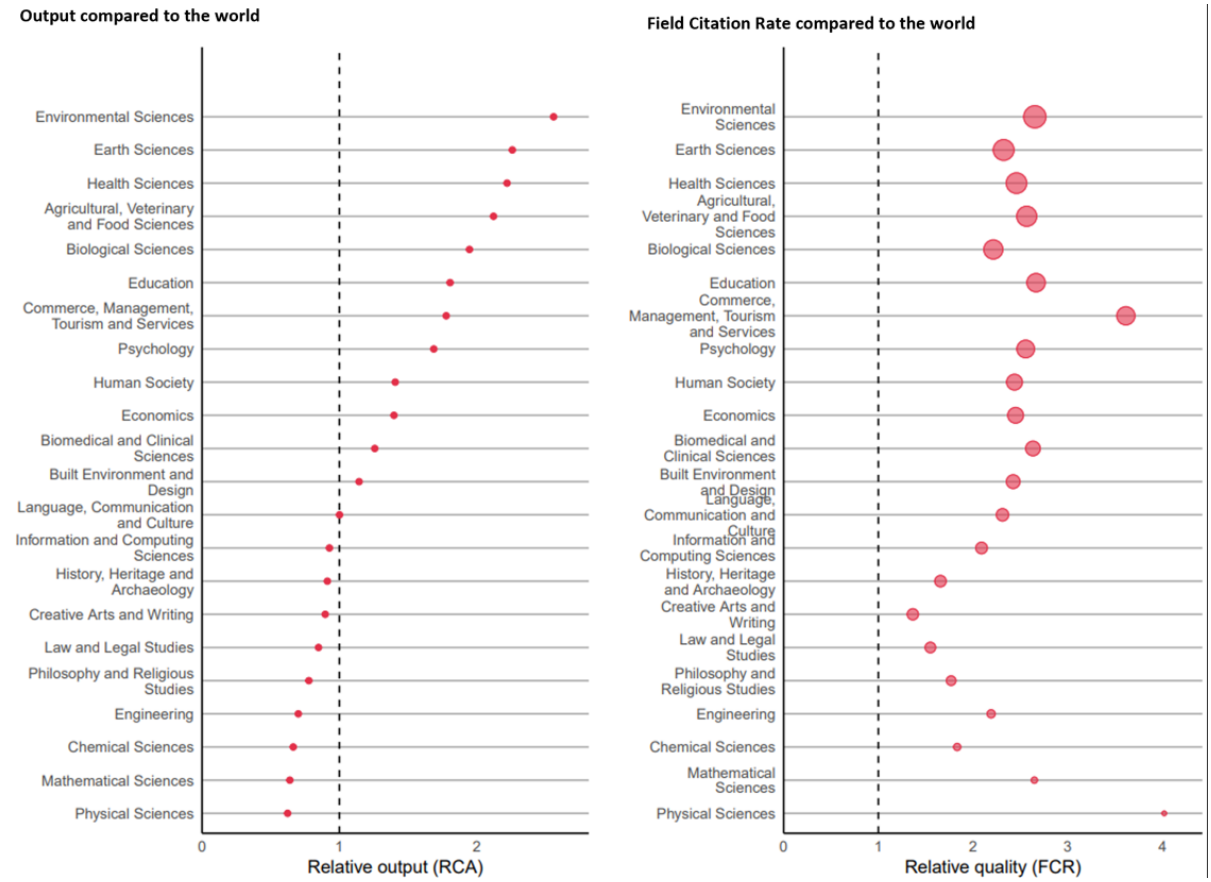
This data show that in 2022:

- Government R&D is mostly directed towards health, environment, primary industries, and manufacturing. These areas accounted for about 84 per cent of all Government expenditure on R&D.
- Business R&D expenditure was targeted towards manufacturing, primary industries, health, and information and communication services. This accounted for 74 per cent of overall business R&D expenditure.
- Higher education R&D expenditure was focussed on health, education and training, general knowledge, cultural understanding, and the environment. These areas comprised 53 per cent of all higher education expenditure on R&D.
- 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%).
- In contrast, the higher education sector mostly undertook R&D to benefit cultural understanding (84 per cent) and education and training (68 per cent)

The conclusions above are consistent with the data on research outputs, in that a significant proportion of research is undertaken for the primary industry sector and health and biomedical sectors. It also emphasises that business sector R&D is likely under-represented in terms of publication metrics, and that this is particularly acute in manufacturing, information and communication services, construction, and transport.

NEW ZEALAND RESEARCH SPECIALISATION 2013–2022

Figure 5 New Zealand research specialisation, plots compare the output and citation of publications between New Zealand and the world. (Data from Digital Sciences' Dimensions platform)



Plots are drawn in order of decreasing RCA. An RCA of 1 represents the baseline of the world average for publications within the same year and research area.

In the plot on the right, the **Field Citation Ratio (FCR)** for each field of research in New Zealand is shown as an indication of publication quality. The FCR measures the average number of citations New Zealand-authored papers received, relative to the global average for papers in the same field. The size of the circles indicates the RCA for the field of research. An FCR of 1 represents the world average for publications within the same year and research area.

The country specialises in the following narrow research areas (second-level ANZSRC Fields of Research classification), measured by its relative output and relative quality. These areas are ordered according to a combination of relative volume and citation (FCR). Data spans across 2013–2022.

Field of Research	% Output	Pubs/Year	RCA	Avg. FCR	Institutes (Citations)
Climate Change Impacts and Adaptation	0.98%	1,707	8.21	2.76	Plant & Food Research (2708); Manaaki Whenua - Landcare Research (12937); AgResearch (4053)
Tourism	0.82%	1,419	3.79	5.24	University of Canterbury (14341); Massey University (2238); University of Waikato (4010)
Commercial Services	1.07%	1,854	3.17	5.04	Institute of Environmental Science and Research (95); University of Canterbury (14305); University of Waikato (5111)
Marketing	1.33%	2,314	2.89	5.49	Manukau Institute of Technology (336); AgResearch (133); Plant & Food Research (1038)
Particle and High Energy Physics	0.81%	1,399	1.35	9.24	University of Canterbury (45406); University of Auckland (36348)

MEASURING NZ RESEARCH EXCELLENCE

Figure 6 Relative 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

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 per cent of France's publications were in Medical Science, compared to 5 per cent globally in that field in 2020, France would have an RCA of 2 for Medical Science in 2020.

New Zealand's 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 (except for Health Sciences, where most of the research is undertaken in universities). In contrast, New Zealand produces fewer publications than the world average in Engineering and the Chemical, Mathematical and Physical Sciences.

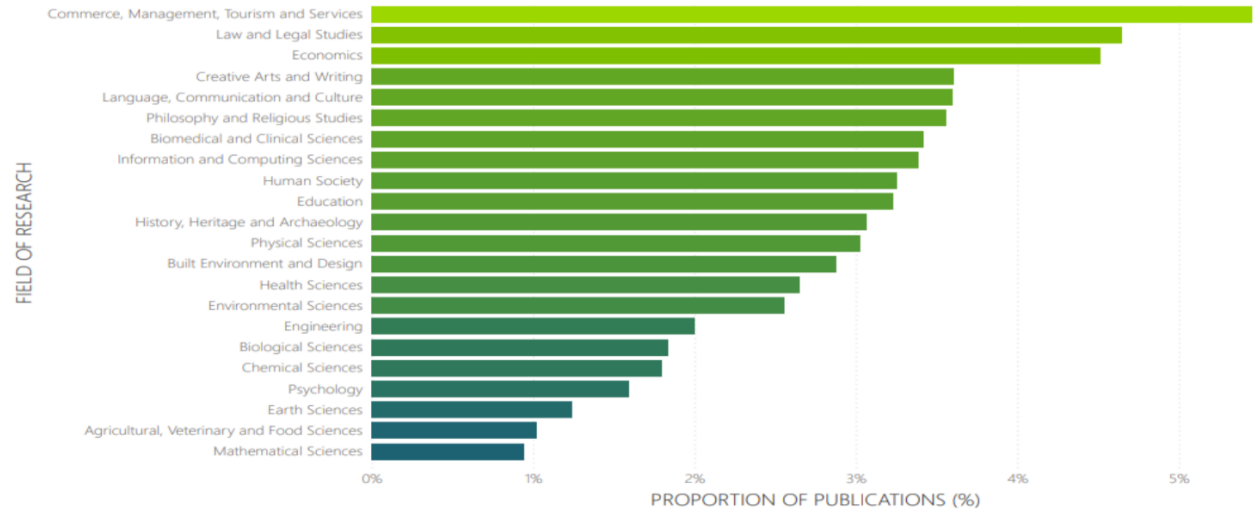
The relative quality of New Zealand publications (measured by the FCR) declined from 2.6 to 2.1 between 2013 and 2022 but remains twice the world average (FCR 1, by definition). This decline is seen across most advanced economies, and can be largely attributed of the rapid growth in the contributions 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.

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.

Figure 7: Proportion of New Zealand-based publications in the top 1% of world research, by field, 2022. Data source Dimensions AI

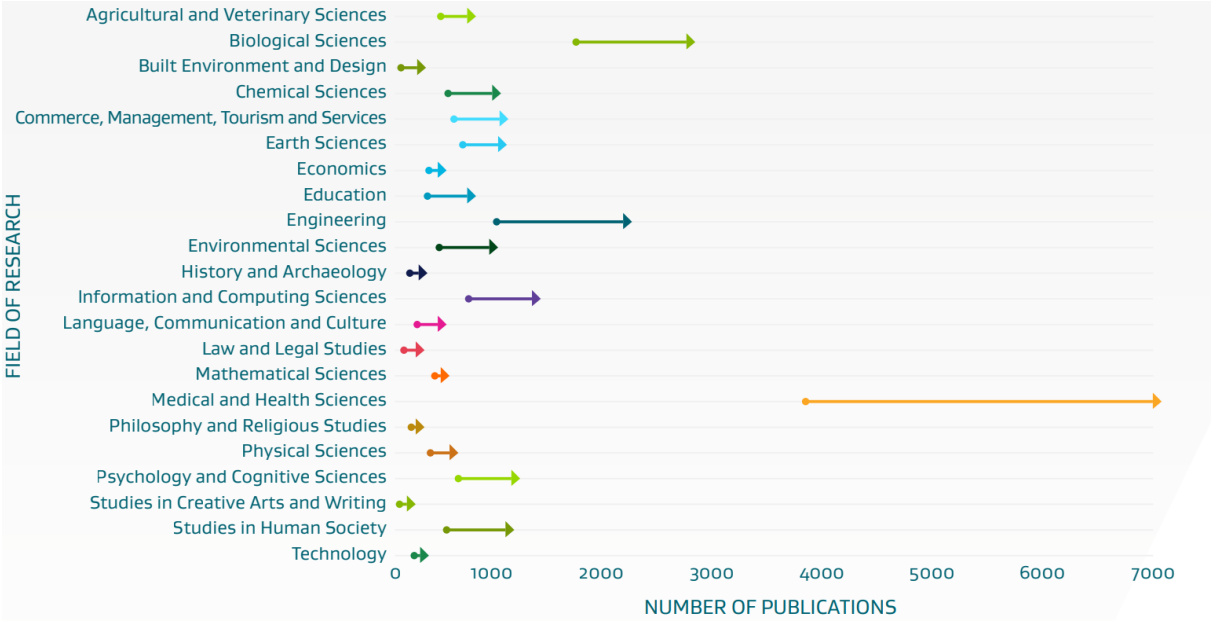


TRENDS IN RESEARCH FIELDS

Change in number of publications by research field in 2010 and 2020

A change in the number of publications is used to indicate increases or decreases in research activity in a particular field. New Zealand produced more publications across all research fields in 2020 when compared to 2010.

Figure 8 Field of research change in publications 2010-2020



A field of research is assigned to every publication (with New Zealand affiliated authors) using the Australian and New Zealand Standard Research Classification. The data in the figure is for publications in these research fields in 2010 and 2020. The head of each arrow indicates the number of publications in 2020.

ORGANISATIONAL SPECIALISATION BASED ON PUBLICATION DATA (2018 TO 2023)

Figure 10 Heatmap of CRI and University research specialisation

FoR Group	AgResearch	ESR	GNS Science	Landcare Research	NIWA	Plant & Food Research	Scion	CRIs (combined)	UoA	AUT	University of Waikato	Massey University	VUW	University of Canterbury	Lincoln University	University of Otago	Universities (combined)	New Zealand (total)
Agricultural, Veterinary and Food Sciences	6.95	1.04	0.43	1.93	0.70	6.46	3.57	3.31	0.44	0.39	0.44	3.11	0.19	0.41	5.48	0.51	0.87	1
Biological Sciences	2.87	3.23	0.52	4.36	3.07	3.87	3.48	3.03	0.81	0.34	0.92	1.23	0.81	0.94	2.00	1.13	0.92	1
Biomedical and Clinical Sciences	0.53	1.00	0.00	0.08	0.04	0.26	0.03	0.24	1.18	0.59	0.29	0.47	0.30	0.24	0.19	1.58	0.87	1
Built Environment and Design	0.28	0.00	0.27	0.39	0.22	0.23	0.60	0.27	1.05	1.77	1.00	1.65	1.42	1.11	0.91	0.41	1.07	1
Chemical Sciences	1.03	1.96	0.80	0.43	0.22	1.14	1.59	0.87	1.37	0.38	0.72	0.86	1.96	1.43	0.38	0.83	1.06	1
Commerce, Management, Tourism and Services	0.16	0.19	0.10	0.17	0.06	0.41	0.24	0.17	0.64	2.31	1.99	1.69	1.22	1.21	1.77	0.75	1.16	1
Creative Arts and Writing	0.04	0.16	0.05	0.00	0.04	0.10	0.00	0.05	0.88	2.50	1.33	1.14	1.44	0.78	0.22	0.42	1.09	1
Earth Sciences	0.44	1.05	14.01	1.79	8.72	0.40	0.65	4.37	0.64	0.21	1.36	0.69	1.61	1.34	0.91	0.84	0.85	1
Economics	0.30	0.00	0.03	1.15	0.33	0.10	1.06	0.42	0.60	1.27	2.41	1.25	1.52	0.83	3.05	0.72	1.12	1
Education	0.05	0.05	0.03	0.13	0.06	0.00	0.09	0.06	1.16	1.32	2.15	0.91	1.24	1.22	0.15	0.75	1.12	1
Engineering	0.48	0.66	1.25	0.21	0.61	0.49	2.00	0.72	1.32	1.32	1.25	0.78	0.99	1.98	0.59	0.33	1.08	1
Environmental Sciences	2.67	2.65	0.69	6.80	5.40	2.72	5.48	3.61	0.70	0.40	1.30	0.93	0.84	1.32	3.49	0.59	0.86	1
Health Sciences	0.11	0.72	0.01	0.06	0.05	0.11	0.05	0.10	1.13	1.99	0.73	0.85	0.50	0.45	0.16	1.60	1.04	1
History, Heritage and Archaeology	0.13	1.17	0.23	0.53	0.19	0.11	0.00	0.25	0.77	0.45	1.18	0.79	1.39	0.91	0.61	1.59	1.09	1
Human Society	0.19	0.88	0.32	0.66	0.20	0.10	0.49	0.32	0.86	1.02	1.67	1.46	1.73	1.22	1.17	0.96	1.14	1
Information and Computing Sciences	0.15	0.58	0.11	0.29	0.18	0.19	0.21	0.21	1.08	1.98	1.17	0.81	1.91	1.16	0.37	0.41	1.13	1
Language, Communication and Culture	0.04	0.00	0.07	0.10	0.02	0.09	0.05	0.05	0.91	1.41	1.58	1.36	2.14	1.28	0.22	0.52	1.17	1
Law and Legal Studies	0.08	3.03	0.11	0.28	0.75	0.10	0.21	0.44	0.84	0.79	1.38	0.73	1.94	1.28	0.23	0.73	1.01	1
Mathematical Sciences	0.08	1.61	0.34	0.25	0.22	0.03	0.27	0.27	1.43	0.54	0.69	1.04	1.94	1.93	0.14	0.62	1.17	1
Philosophy and Religious Studies	0.07	0.26	0.04	0.23	0.14	0.00	0.09	0.10	0.70	1.17	1.63	0.79	1.35	1.06	0.21	1.44	1.08	1
Physical Sciences	0.12	0.42	1.12	0.15	0.17	0.10	0.36	0.34	1.36	0.54	0.46	0.67	1.94	4.07	0.22	0.60	1.10	1
Psychology	0.06	0.28	0.00	0.03	0.03	0.05	0.00	0.05	1.10	1.20	1.50	0.84	1.55	1.11	0.09	1.40	1.18	1

An RCA of greater than 1 indicates that an organisation has published more papers in a particular field relative to New Zealand.

The background colour of each cell represents the size of the number.

- Dark red for high values which indicates a greater than expected focus in that field.
- White for low values which indicates a lower than expected focus in that field

The heat map illustrations how the CRIs research activities reflect their sectoral focus.

DEEPER DIVE ON RESEARCH SPECIALISATION

Research specialisation of individual organisations can be further refined to demonstrate narrow research areas (second-level ANZSRC Fields of Research classification), measured by its relative output and relative quality. An example of this output is provided for both University of Auckland and AgResearch in Annex 1, as an indication of information that is available if required.

Annex 2 shows examples of research specialisation at second-level ANZSRC Fields of Research classification; these are provided for biological sciences and physical sciences, which are fields of high research activity and low research activity, respectively. The distributions of activity across a field of research demonstrates that within a discipline there are areas of strengths and areas of low activity.

WORLD RANKING BY SUBJECT OF NEW ZEALAND UNIVERSITIES

The world ranking of NZ universities broadly shows the areas of research strength. For example, the International higher education analyst Quacquarelli Symonds (QS) rankings by subject (2024). There were 190 instances where New Zealand universities were ranked by QS across 49 subject areas.

Figure 11 New Zealand Universities that achieved a top 50 ranking.

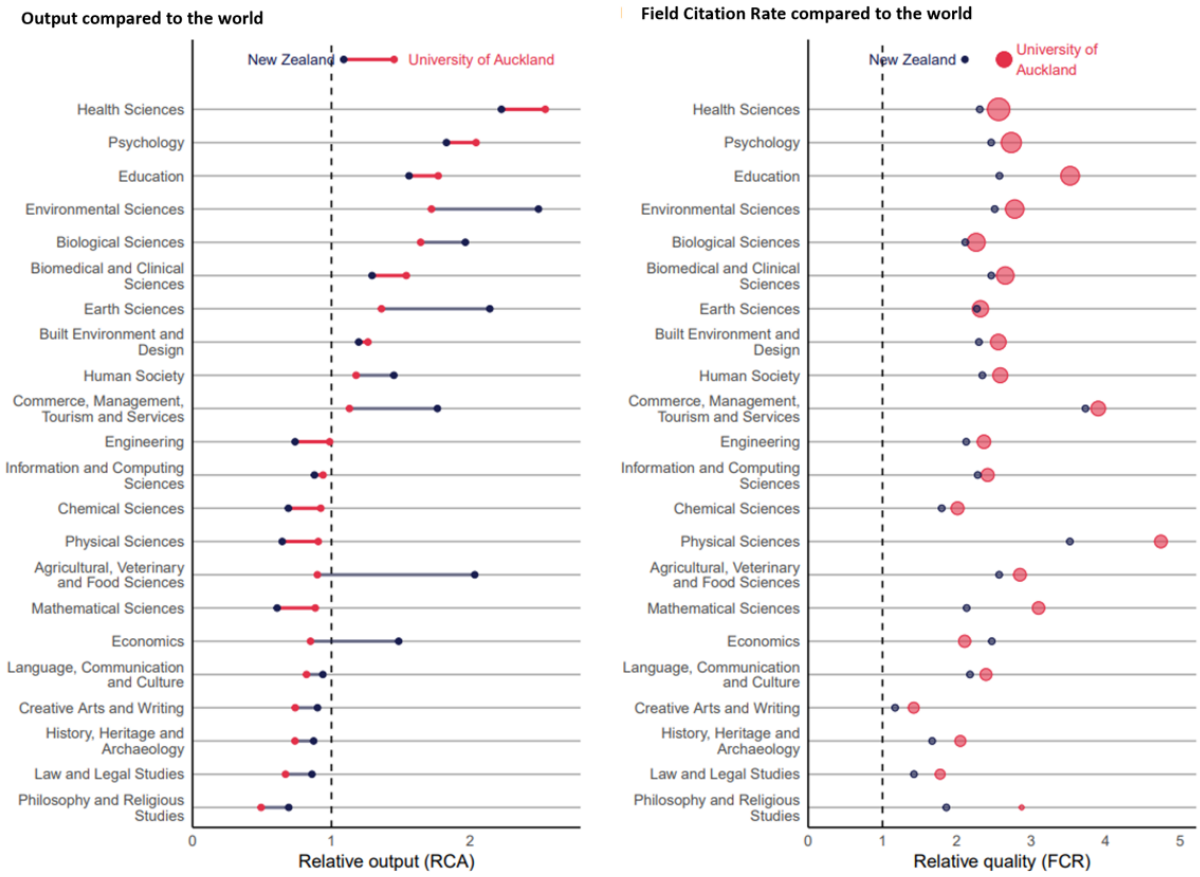
New Zealand Entries in Top 50			
2024	**2023**	**Institution**	**Subject**
12	15	University of Otago	Sports-related Subjects
21-50		The University of Auckland	Marketing
21	28	Massey University	Veterinary Science
28	41	Auckland University of Technology (AUT)	Sports-related Subjects
28	32	The University of Auckland	Sports-related Subjects
30	29	Massey University	Development Studies
30	39	University of Otago	Anatomy & Physiology
37	37	The University of Auckland	Education
39	46	The University of Auckland	Archaeology
40	42	University of Otago	Dentistry
44		University of Otago	Hospitality & Leisure Management
45	62	The University of Auckland	Psychology
45	51-100	The University of Auckland	Anatomy & Physiology
46	45	The University of Auckland	Engineering - Civil & Structural
48	55	Victoria University of Wellington	Linguistics
48	47	The University of Auckland	English Language & Literature
48	47	The University of Auckland	Anthropology
49	62	The University of Auckland	Linguistics

However, rankings have to be considered with caution as they convert proxy measures of a few academic activities into numeric metrics, to come up with a ranking of institutions. The criteria may be entirely unrelated to each other or may be poor proxies of the academic activity being measured. Many of the criteria could be seen as descriptive rather than evaluative.

ANNEX 1 EXAMPLES OF ORGANISATIONAL RESEARCH SPECIALISATION

University of Auckland

Research specialisation 2018 – 2022
The following plots compare the output and citation of publications between New Zealand and University of Auckland. The publication data for New Zealand is inclusive of publications affiliated with University of Auckland. (Data from Digital Sciences' Dimensions platform)



We measure the RCA for each field of research in University of Auckland as an indication of publication volume. Plots are drawn in order of decreasing RCA. An RCA of 1 represents the baseline of the world average for publications within the same year and research area.

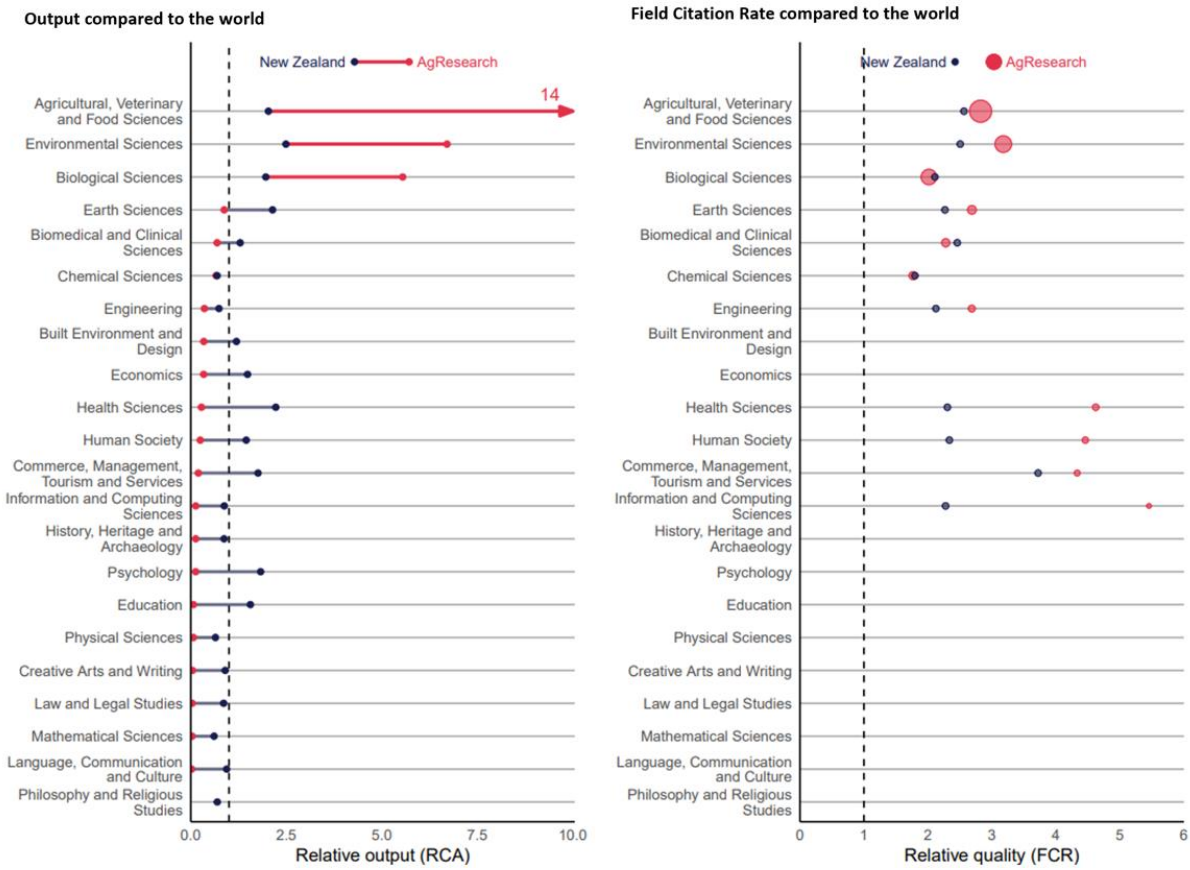
We measure the Field Citation Ratio (FCR) for each field of research in University of Auckland as an indication of publication quality. The size of the circles indicates the RCA for the field of research. An FCR of 1 represents the world average for publications within the same year and research area.

The institute specialises in the following narrow research areas (second-level ANZSRC Fields of Research classification), measured by its relative output and relative quality. These areas are ordered according to a combination of relative volume (RCA) and citation (FCR). Data for 2018 and 2022.

Field of Research	% Total Research Output	Pubs/Year	RCA	Avg. FCR	Key Researchers (Citations)
Particle and High Energy Physics	1.91%	105.6	3.67	7.91	Dan J Krofcheck (4821)
Nuclear and Plasma Physics	1.47%	81.2	2.47	8.29	Dan J Krofcheck (4277)
Climate Change Impacts and Adaptation	0.88%	48.8	6.74	2.82	Shyama N Pagad (583); David W Waite (191); Luitgard Schwendenmann (186)
Paediatrics	1.81%	100	3.73	3.82	Jane Elizabeth Harding (913); Alistair Jan Gunn (855); Stuart R Dalziel (671)
Nutrition and Dietetics	1.97%	109	4.13	3.15	Boyd Anthony Swinburn (896); Lindsay Dudley Plank (617); Robert Keith Rhodes Scragg (549)
Public Health	4.93%	272.8	3.88	2.5	Boyd Anthony Swinburn (1580); Rod T Jackson (1076); Virginia Braun (1037)
Ophthalmology and Optometry	2.11%	116.4	3.37	2.8	Jennifer Patricia Craig (934); Michael Tzu Min Wang (727); Charles N J Mcghee (589)
Reproductive Medicine	2.75%	152	2.38	3.84	Lesley M E Mccowan (1161); Peter David Gluckman (934); Caroline A Cac Crowther (889)
Social and Personality Psychology	0.82%	45.4	2.58	3.42	Virginia Braun (1888); Chris G Sibley (908); Danny Osborne (576)

AgResearch

Research specialisation 2018 – 2022
The following plots compare the output and citation of publications between New Zealand and AgResearch. The publication data for New Zealand is inclusive of publications affiliated with AgResearch. (Data from Digital Sciences' Dimensions platform)



We measure the Revealed Comparative Advantage (RCA) for each field of research in AgResearch as an indication of publication volume. Plots are drawn in order of decreasing RCA. An RCA of 1 represents the baseline of the world average for publications within the same year and research area.

We measure the Field Citation Ratio (FCR) for each field of research in AgResearch as an indication of publication quality. The size of the circles indicates the RCA for the field of research. An FCR of 1 represents the world average for publications within the same year and research area.

The institute specialises in the following narrow research areas (second-level ANZSRC Fields of Research classification), measured by its relative output and relative quality. These areas are ordered according to a combination of relative volume (RCA) and citation (FCR). Data for 2018 and 2022.

Field of Research	% Total Research Output	Pubs/Year	RCA	Avg. FCR	Key Researchers (Citations)
Animal Production	18.86%	73.6	54.08	2.92	Mhairi Anne Sutherland (335); Mustafa M Farouk (289); Mairi Stewart (287)
Agriculture, Land and Farm Management	6.97%	27.2	26.6	3.24	Jia-Fa Luo (685); Stuart B Lindsey (375); Richard William Mcdowell (366)
Soil Sciences	3.13%	12.2	19.5	3.61	Jia-Fa Luo (301); Stuart B Lindsey (178); Richard William Mcdowell (110)
Crop and Pasture Production	13.99%	54.6	22.9	2.88	Jia-Fa Luo (843); Stuart B Lindsey (466); Richard William Mcdowell (348)
Climate Change Impacts and Adaptation	1.64%	6.4	12.52	2.61	Val Snow (87); Jia-Fa Luo (70); Barbara I P Barratt (46)
Plant Biology	6.41%	25	11.43	2.6	Paul C D Newton (276); Daniel A Bastías (186); Michael John Christensen (160)
Veterinary Sciences	4.72%	18.4	10.48	2.79	Dave M Leathwick (159); Bryce Malcom Buddle (132); Tania S Waghorn (69)
Zoology	4.97%	19.4	12.94	2.04	Mhairi Anne Sutherland (149); Mairi Stewart (117); Vanessa Marion Cave (104)
Food Sciences	5.79%	22.6	8.16	3.18	Li Day (312); Aswathi Soni (145); Hanh Thi Hong Nguyen (135)

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ANNEX 2. EXAMPLES OF FIELD OF RESEARCH SPECIALISATION

Field of Research	Publications	FCR	RCA
⊟ Biological Sciences			
3101 Biochemistry and Cell Biology	3315	1.82	1.00
3102 Bioinformatics and Computational Biology	1162	2.31	1.31
3103 Ecology	9126	2.32	4.00
3104 Evolutionary Biology	2270	2.02	4.08
3105 Genetics	4385	2.26	2.51
3106 Industrial Biotechnology	652	2.27	1.04
3107 Microbiology	3124	2.35	1.81
3108 Plant Biology	2127	2.29	2.12
3109 Zoology	2396	1.88	3.36
⊟ Physical Sciences			
5101 Astronomical Sciences	925	4.71	1.12
5102 Atomic, Molecular and Optical Physics	539	2.43	0.55
5103 Classical Physics	264	2.80	0.51
5104 Condensed Matter Physics	489	2.40	0.39
5105 Medical and Biological Physics	202	2.78	0.70
5106 Nuclear and Plasma Physics	1205	9.45	0.98
5107 Particle and High Energy Physics	1333	9.11	1.33
5108 Quantum Physics	624	3.11	0.58
5109 Space Sciences	515	4.08	1.15
5110 Synchrotrons and Accelerators	92	3.51	0.24

Field of Research specialisation at second-level ANZSRC Fields of Research classification. Data shows the number of publications, FCR for each field of research and RCA.

Biological Sciences is an area of strong research activity in New Zealand; ecology is strongest, with both most papers and highest FCR citation rate. Within this discipline there are some sector areas with low research activity, e.g. industrial biotechnology.

Physical Sciences has the lowest level of research activity in New Zealand, but the citation rate within this sector shows two areas of strength. Nuclear and particle physics fields have the largest number of physics papers, with a very high FCR citation rate at over 9. This includes eminent physicists publishing with CERN megaprojects that have papers with numerous authors and good citation rates. Astronomy and space science also contribute to overall high FCR citation rate of physics as a whole.