

Motu Economic and Public Policy Research
Level 1, 97 Cuba Street
PO Box 24390, Wellington 6142
New Zealand
Ph 64-4-939 4250

motu.org.nz

Research and Commercial Innovation in New Zealand: Background Report for SfTI Industry-Led Discussions

Motu Economic and Public Policy Research

Revised April 2017

Author contact details

Adam Jaffe

Motu Economic and Public Policy Research and Queensland University of Technology
adam.jaffe@motu.org.nz

Nathan Chappell

Motu Economic and Public Policy Research
nathan.chappell@motu.org.nz

Data disclaimer¹

The results in this paper are not official statistics, they have been created for research purposes from the Integrated Data Infrastructure (IDI) managed by Statistics New Zealand. The opinions, findings, recommendations and conclusions expressed in this paper are those of the authors, not Statistics New Zealand, the Treasury, the Ministry of Business, Innovation and Employment, or Motu Economy & Public Policy Research.

Access to the anonymised data used in this study was provided by Statistics New Zealand in accordance with security and confidentiality provisions of the Statistics Act 1975. Only people authorised by the Statistics Act 1975 are allowed to see data about a particular person, household, business or organisation and the results in this paper have been confidentialised to protect these groups from identification. Careful consideration has been given to the privacy, security and confidentiality issues associated with using administrative and survey data in the IDI. Further detail can be found in the privacy impact assessment for the IDI available from www.stats.govt.nz.

The results are based in part on tax data supplied by Inland Revenue to Statistics New Zealand under the Tax Administration Act 1994. This tax data must be used only for statistical purposes, and no individual information may be published or disclosed in any other form, or provided to Inland Revenue for administrative or regulatory purposes. Any person who has had access to the unit-record data has certified that they have been shown, have read, and have understood section 81 of the Tax Administration Act 1994, which relates to secrecy. Any discussion of data limitations or weaknesses is in the context of using the IDI for statistical purposes, and is not related to the data's ability to support Inland Revenue's core operational requirements.

¹ Disclaimer applies to Section III of this report

Contents

I.	Introduction	4
II.	Physical science and engineering research in NZ	5
A.	Overall number of researchers.....	5
B.	Research output of NZ universities and CRIs.....	7
C.	Triadic patent applications	11
III.	Economic activity in relevant industries	14
A.	Industries with significant firm-level R&D.....	15
B.	Engagement of firms with public research entities.....	16
C.	Basic Research	18
D.	Reported innovation rates	19
E.	Indicators of emergent industries	20

Figures

Figure 1: R&D personnel, NZ & comparator countries	5
Figure 2: Research output by subject area, NZ institutions	8
Figure 3: Patents by technology type, NZ & comparator countries	12

Tables

Table 1: Industries with greatest absolute amount of R&D spending	16
Table 2: Industries with highest R&D intensity firms	16
Table 3: Industries with highest & lowest rates of engagement with CRIs & universities ...	17
Table 4: Industries with highest & lowest proportions of R&D deemed “basic”	18
Table 5: Industries with highest & lowest proportions of firms that report having innovated in the last year	19
Table 6: Industries with highest proportions of new firms	20
Table 7: Fastest growing industries	21

I. Introduction

This document is a background report on physical science and engineering research in NZ, and commercial innovation and activity in NZ industries. We have collated the best available data on:

- the number of research and development personnel in NZ compared with other small countries, and whether these researchers are in business, the government or the tertiary education system;
- the research output of NZ universities and Crown Research Institutes (CRIs) for different subject areas related to physical science and engineering;
- the intensity of triadic patent applications by NZ inventors for different patent technology areas, compared with other small countries;
- economic activity in relevant industries, ranging from R&D intensity to engagement with CRIs and universities to the proportion of R&D expenditure that is basic;

This report does not try to explain the patterns presented; we do not give prescriptions on how the links between research and commercial innovation could be strengthened. Rather, the goal is to present a common set of background patterns for participants, to help inform discussion.

The data presented on research output and patents is based on quite broad or aggregate groupings of disciplines and technology areas. Appendix I presents the same data broken down into more detailed or finer areas of science and technology. The data presented on economic activity is for a subset of industries that rank particularly high or particularly low with respect to particular activity metrics. Appendix II presents the data on these metrics for all New Zealand industries.

II. Physical science and engineering research in NZ

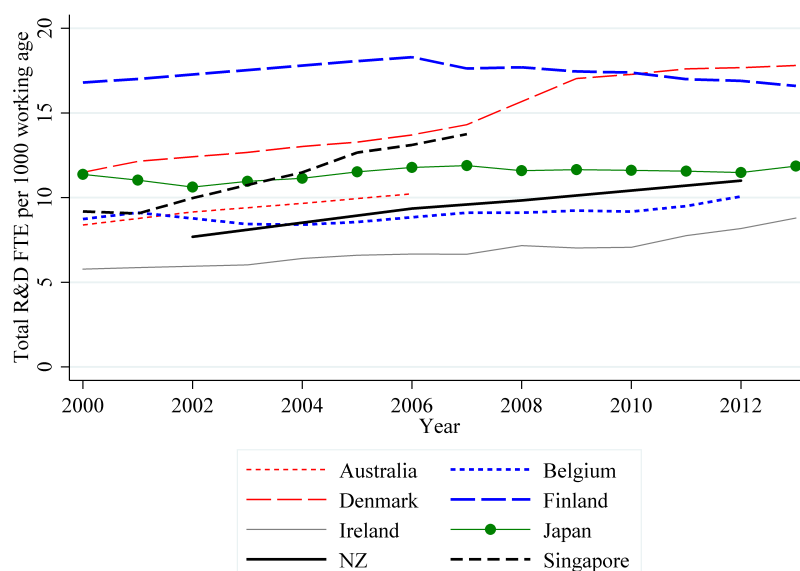
A. Overall number of researchers

This section shows the number of people doing work related to R&D as a proportion of the working age population, for NZ and other comparable countries. R&D personnel are then split into those in the business sector, those in government, and those in the tertiary education system.

Panel A of Figure 1 shows recent trends in the overall fraction of the population devoted to research in a handful of other relatively small developed economies. While New Zealand has been trending upward slightly on this measure, it remains below Denmark, Finland, Singapore, Japan, and Australia. Its ratio is above that of Ireland, and slightly above that of Belgium.

Figure 1: R&D personnel, NZ & comparator countries

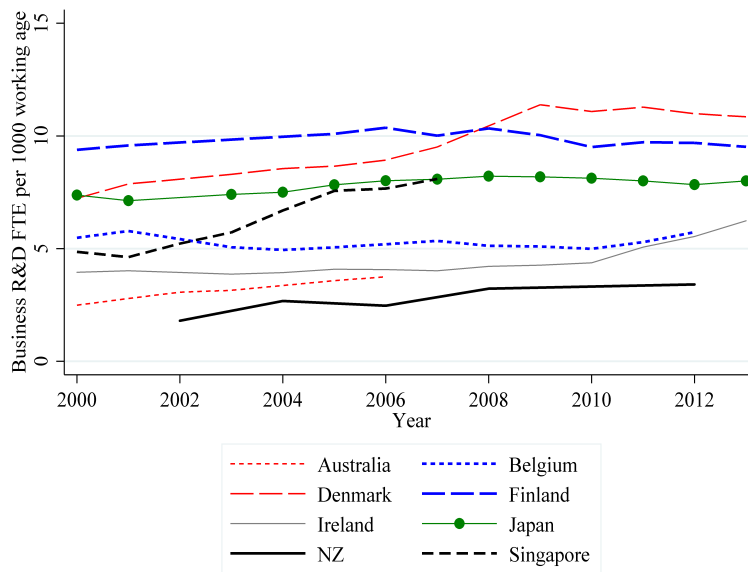
Panel A: Total R&D personnel



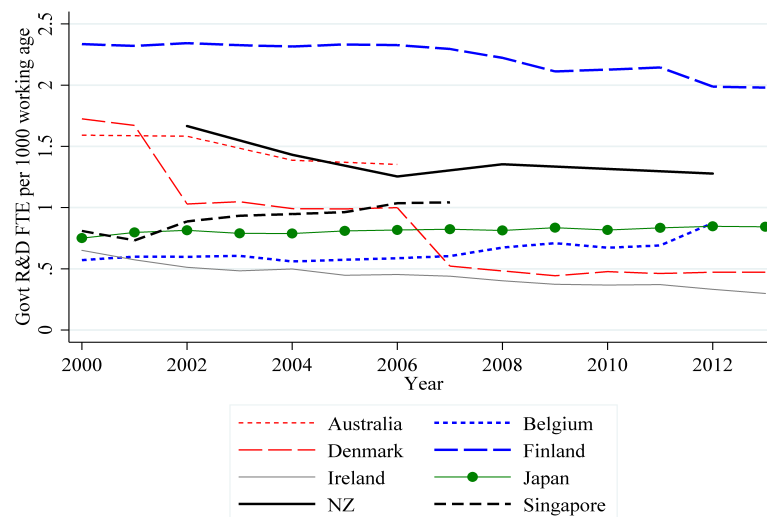
Panel B of the Figure shows that New Zealand's relatively low overall ratio is driven by the very low fraction of its population engaged in research in the business sector. On this measure, New Zealand is below all of these comparator countries., and the ratio has barely risen over the time period.

Panel C shows that the general tendency in all of these countries over the 2000-2013 period has been a decline in research personnel in the government sector, relative to the population as a whole. Such a downward trend is clear for New Zealand. Nonetheless, overall the fraction of New Zealand's population engaged in research in the government sector is among the highest in this comparator group, exceeded only by Finland.

Panel B: Business R&D personnel



Panel C: Government R&D personnel



Panel D shows the trends for researchers in the tertiary education sector. This sector shows the strongest growth of any sector for New Zealand, with the ratio rising by more than 50% between 2002 and 2012. Partly as a result, at the end of the period New Zealand is essentially tied with Denmark for the highest share of its population engaged in university research among these comparator countries.

Looked at overall, these charts show that in terms of numbers of researchers, New Zealand has a relatively high level of activity in the non-commercial sectors of government and universities, but a very low level of activity in the business sector. Since the business sector is the largest of the three, this translates into a relatively low level of overall research activity. The low level of activity in the business sector also forms the basis for a concern

that commercial innovation in New Zealand does not receive the same level of technology-driven impetus as in other countries.

Panel D: Tertiary education R&D personnel



Notes: Data come from the OECD Main Science and Technology Indicators (MSTI) dataset. These data, in turn, are derived from each country’s statistical agency who run surveys to estimate the number of R&D personnel in the country. A person contributes to the R&D personnel measure if their job supports research and development in any way.

B. Research output of NZ universities and CRIs

This section measures the research output of NZ universities and CRIs for different subject areas. Two measures are reported: total publications, and the normalized average number of citations received by each publication. The citation normalization is done by dividing the actual average number of citations for a given year and discipline by the world average citations per paper for that discipline and year. This normalization makes the citation rates approximately comparable across time and disciplines.

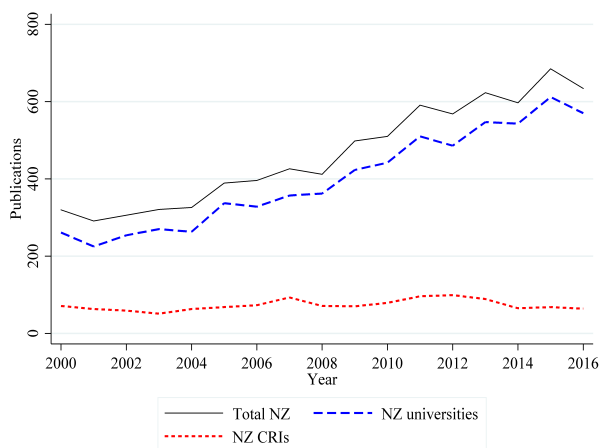
The graphs for the various disciplines share a similar general pattern. Across the board, the number of publications from the university sector is much larger than the total from CRIs, and the university totals are rising over time while the CRI total is generally flat. This increase in university publications may be connected to the increase in the number of university researchers shown in Figure 1 Panel D, and may also reflect the incentives for increased publications created by the PRRF incentive system.

While the number of university publications generally exceeds that of the CRIs, their average quality—to the extent that quality can be captured by citations—is generally about the same. This means, on the one hand, that despite their overall smaller scale, the quality of CRI output appears roughly comparable to university output. Interestingly, it also suggests that the significant increase in total publications from universities over the period is not associated with any apparent shift toward more marginal, lower quality publications. On the contrary,

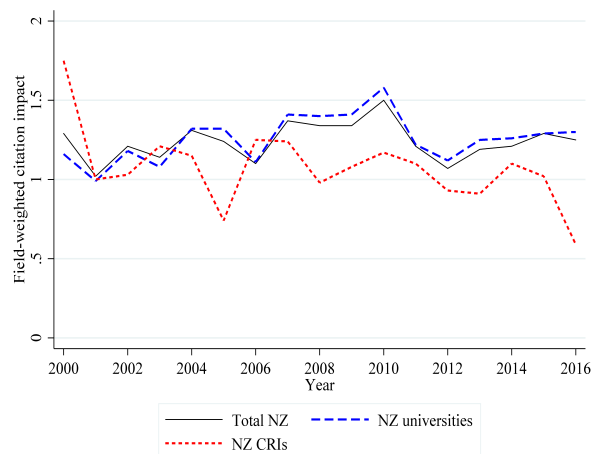
though there are noisy year-to-year variations within each field, the typical pattern is rough maintenance of average quality even as the number of papers increased significantly. Subject again to the caveat that citations measure quality only imperfectly, this implies a significant increase in quality-weighted output (publications times normalized citations per paper) in the tertiary sector in the last decade and a half.

Figure 2: Research output by subject area, NZ institutions

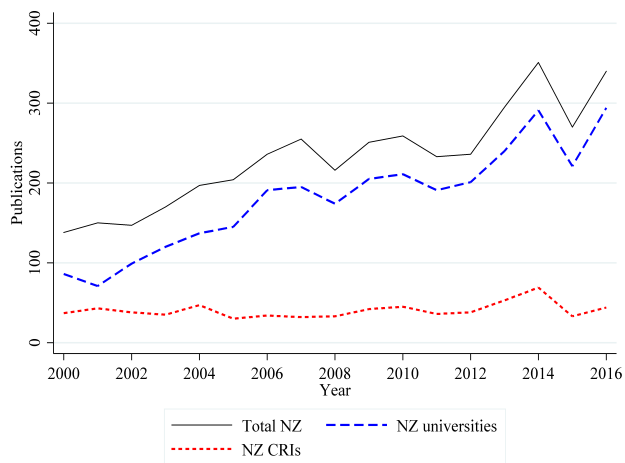
Panel A1: Chemistry publications



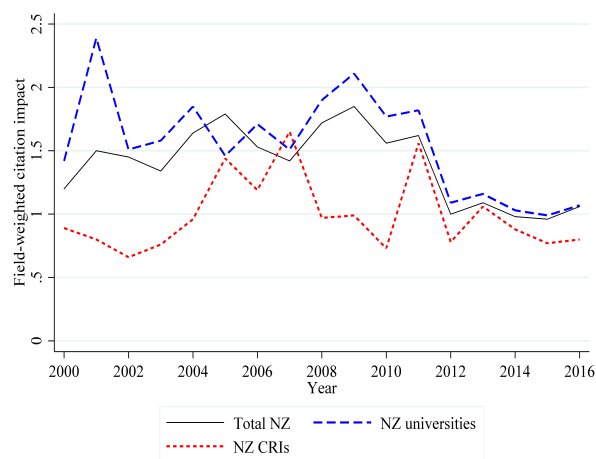
Panel A2: Chemistry citation impact



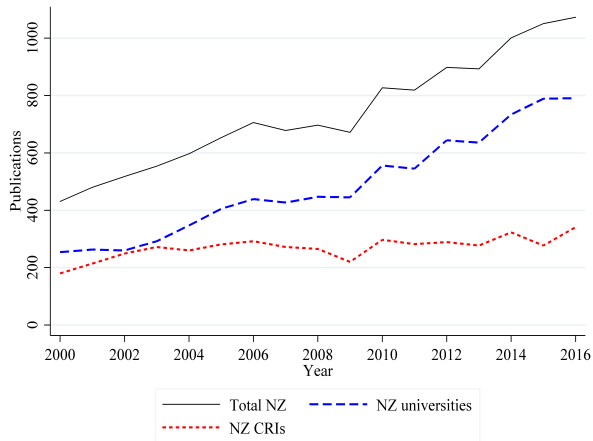
Panel B1: Chemical eng. publications



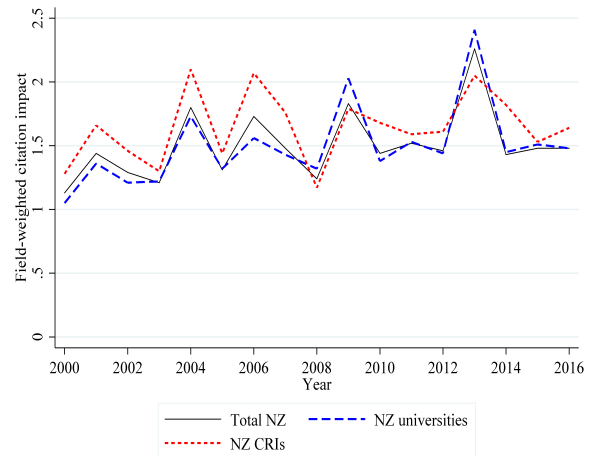
Panel B2: Chemical eng. impact



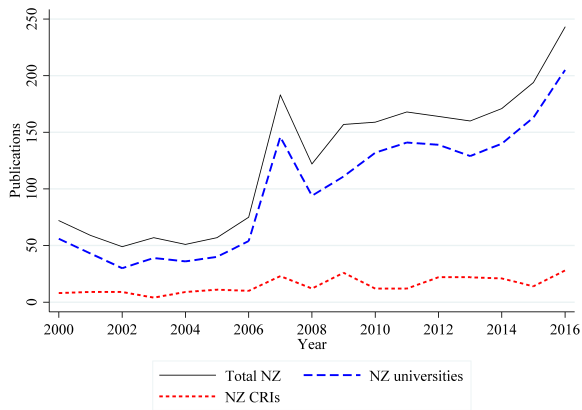
Panel C1: Earth science publications



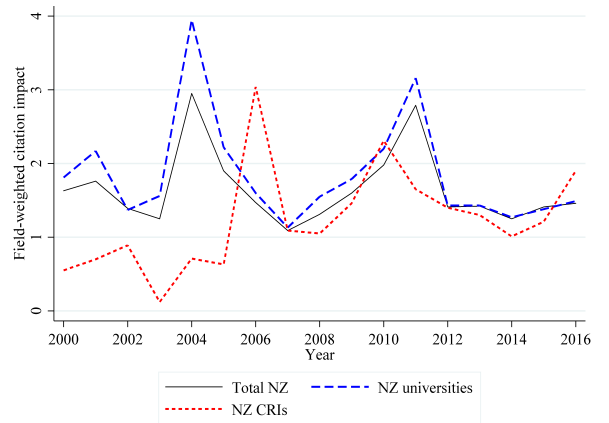
Panel C2: Earth science impact



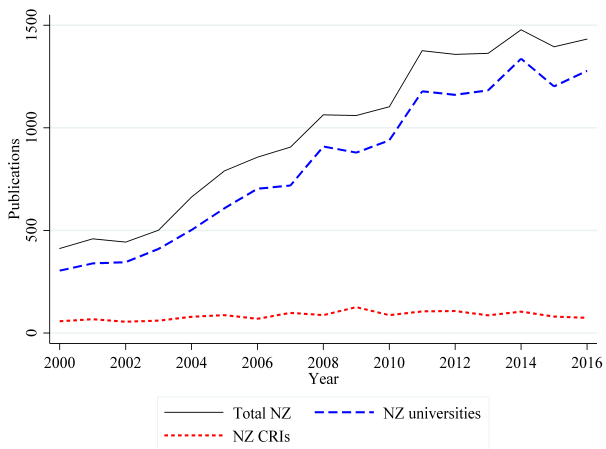
Panel D1: Energy publications



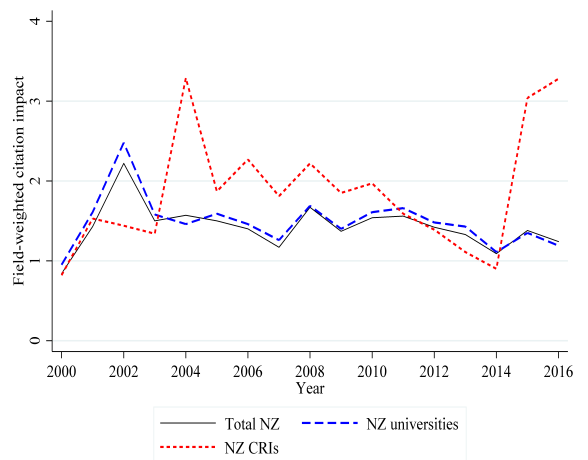
Panel D2: Energy impact



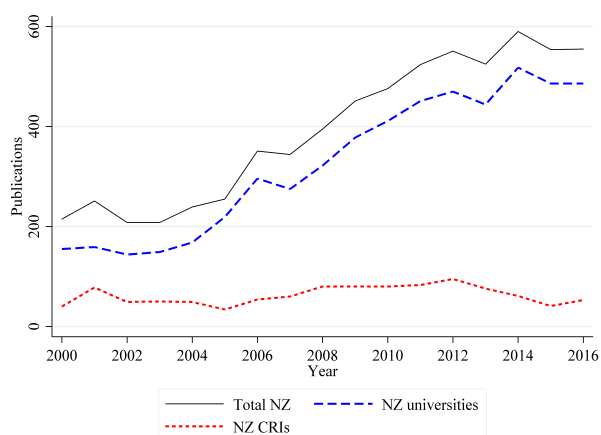
Panel E1: Engineering publications



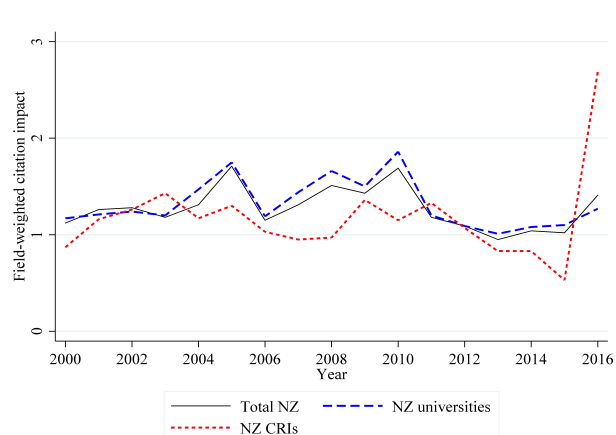
Panel E2: Engineering impact



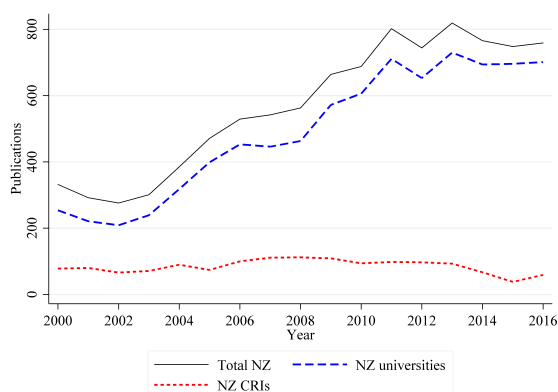
Pane F1: Materials publications



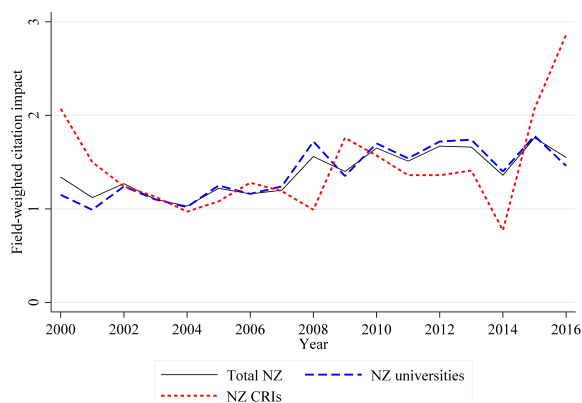
Panel F2: Materials impact



Panel G1: Physics publications



Panel G2: Physics impact



Notes: Data come from SciVal, which uses the Scopus database along with affiliation identifiers to group together the research output of different institutions. The number of publications includes all publication types (articles, reviews, conference papers, editorials and short surveys). The field-weighted citation is the ratio of citations received relative to the expected world average for the subject field, publication type (of which we include all) and publication year. The category 'Total NZ' includes any New Zealand author, regardless of whether they are affiliated with an NZ university or CRI.

Figures 1-7 of Appendix I presents analogous graphs for finer disciplinary breakdowns. The specific sub-disciplines reported are as follows:

- **Chemistry:** Analytical Chemistry; Chemistry (misc.); Electrochemistry; General Chemistry; Inorganic Chemistry; Physical & Theoretical Chemistry; Spectroscopy
- **Chemical Engineering:** Bioengineering; Catalysis; Chemical Engineering (misc.); Chemical Health & Safety; Colloid & Surface Chemistry; Filtration & Separation; Fluid Flow & Transfer Processes; General Chemical Engineering; Process Chemistry & Technology

- **Earth & Planetary Sciences:** Atmospheric Science; Computers in Earth Sciences; Earth & Planetary Sciences (misc.); Earth-Surface Processes; Economic Geology; General Earth & Planetary Sciences; Geochemistry & Petrology; Geology; Geophysics; Geotechnical Engineering & Engineering Geology; Geology; Oceanography; Paleontology; Space & Planetary Science; Stratigraphy
- **Energy:** Energy (misc.); Energy Engineering & Power Technology; Fuel Technology; General Energy; Nuclear Energy & Engineering; Renewable Energy, Sustainability & the Environment
- **Engineering:** Aerospace Engineering; Architecture; Automotive Engineering; Biomedical Engineering; Building & Construction; Civil & Structural Engineering; Computational Mechanics; Control & Systems Engineering; Electrical & Electronic Engineering; Engineering (misc.); General Engineering; Industrial & Manufacturing Engineering; Mechanical Engineering; Mechanics of Materials; Media Technology; Ocean Engineering; Safety, Risk, Reliability & Quality
- **Materials Science:** Biomaterials; Ceramics & Composites; Electronic, Optical & Magnetic Materials; General Materials Science; Materials Chemistry; Materials Science (misc.); Metals & Alloys; Polymers & Plastics; Surfaces, Coatings & Films
- **Physics & Astronomy:** Acoustics & Ultrasonics; Astronomy & Astrophysics; Atomic & Molecular Physics, and Optics; Condensed Matter Physics; General Physics & Astronomy; Instrumentation; Nuclear & High Energy Physics; Physics & Astronomy (misc.); Radiation; Statistical & Nonlinear Physics; Surfaces & Interfaces

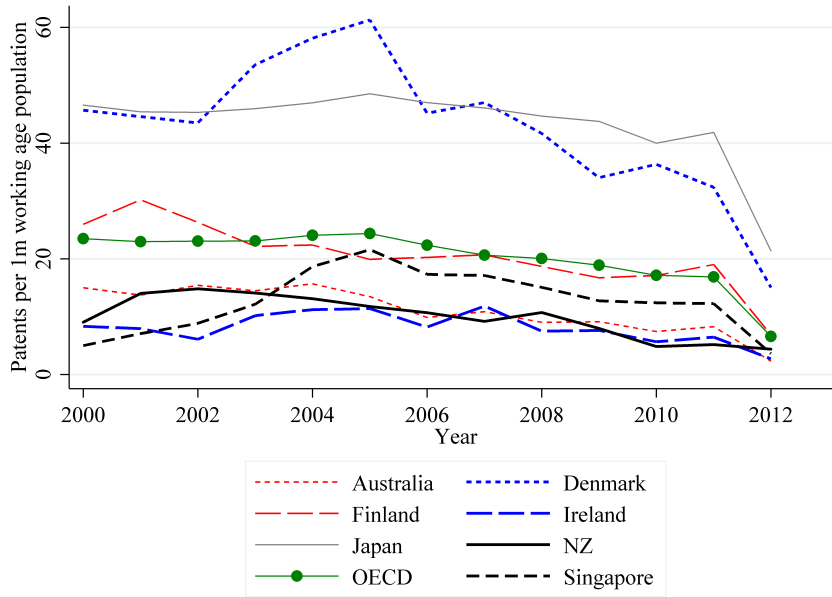
C. Triadic patent applications

Patent applications can be used as a crude indicator of commercial inventive activity. Because many patent applications are never commercialized, it is common to use only those patents for which the owner has sought protection in Europe, Japan and the US (triadic patents) as the invention indicator. Because there is a cost incurred to pursue the patent in each of these jurisdictions, it is assumed that triadic patents represent generally significant inventions. The patent totals are then expressed as a proportion of the working age population, for NZ and other comparable countries. An average for all of the OECD is also presented for comparison.

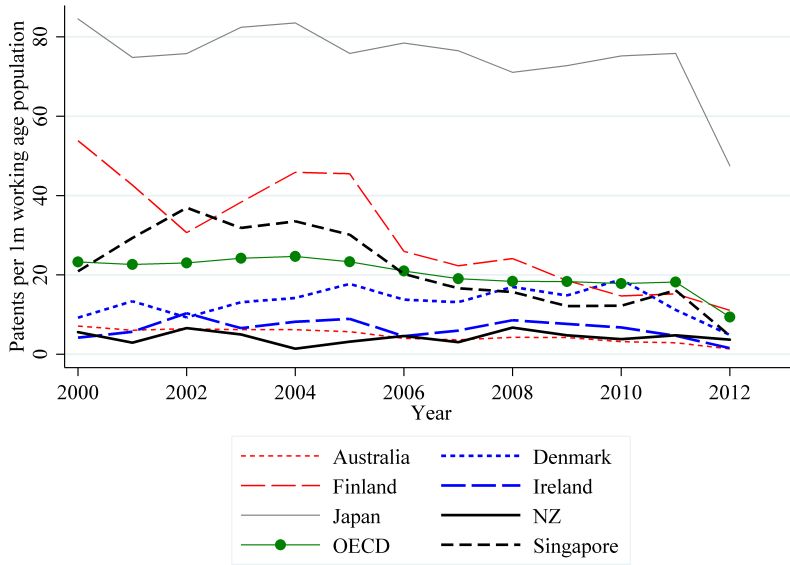
The yearly totals are somewhat noisy, and the position of *other* countries is different in the different technology areas. But the number of triadic patents per capita in New Zealand is low relative to the comparator countries, and low relative to the OECD average, across all technology fields. Figures 8-12 of Appendix I show similar comparisons for more narrowly defined technology fields. Within these narrower fields, it is possible to identify a few where New Zealand's performance is somewhat better. For example, in biotechnology patents, NZ is similar to most comparator countries and the OECD average, though far behind Denmark (Figure 8B). In Food chemistry patents, NZ was second only to Denmark in 2000, but by the end of the period has fallen into the middle of the pack (Figure 8E).

Figure 3: Patents by technology type, NZ & comparator countries

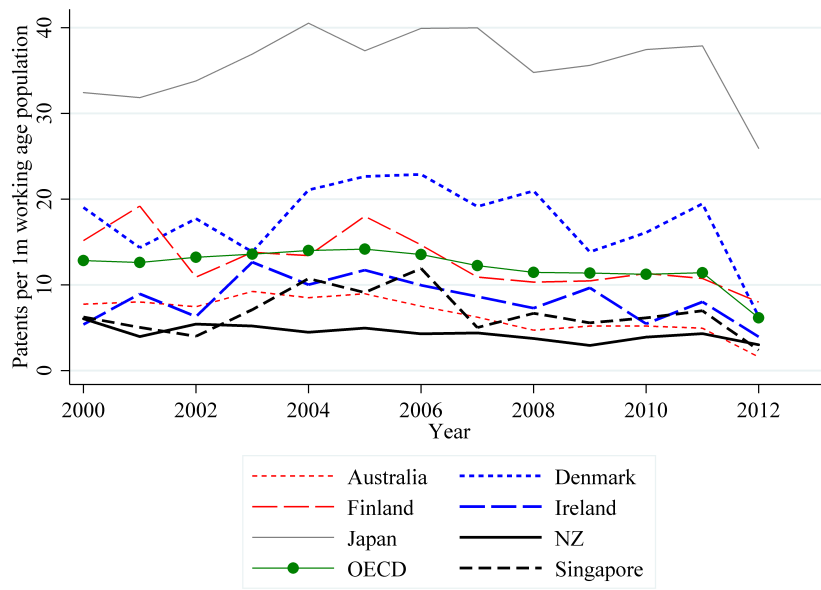
Panel A: Chemistry patents



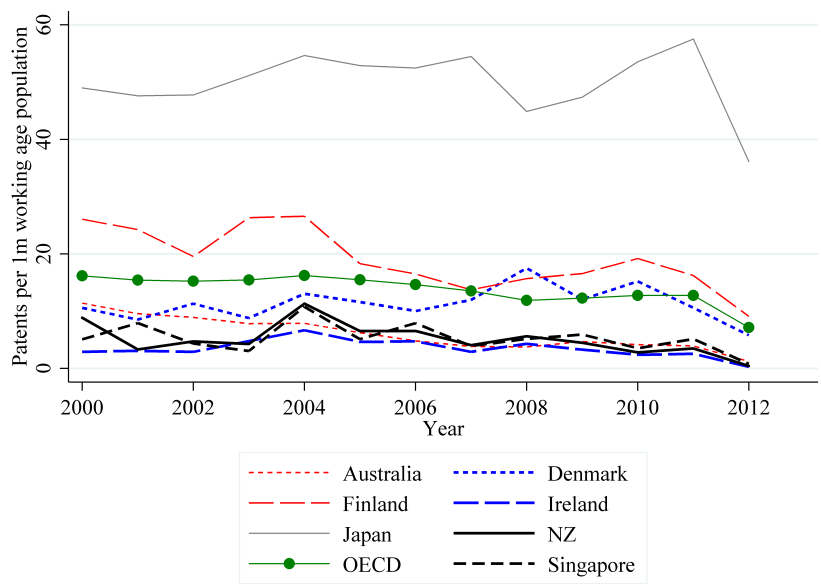
Panel B: Electrical engineering patents



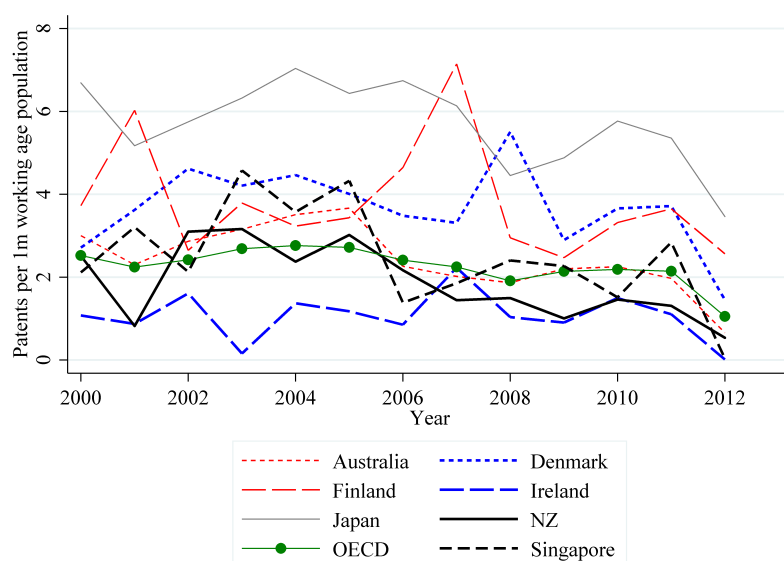
Panel C: Instruments patents



Panel D: Mechanical engineering patents



Panel E: Other patents



Notes: Counts of patents filed by technology field come from the OECD Main Science and Technology Indicators (MSTI) dataset. Data on working age populations come from the OECD Demography and Population dataset. We use the World Intellectual Property Office (WIPO) concordance tables to map International Patent Classification (IPC) codes to the technology types presented. These technology types have been constructed in order to be comparable across different countries. See http://www.wipo.int/export/sites/www/ipstats/en/statistics/patents/pdf/wipo_ipc_technology.pdf for details.

The finer technology class breakdowns shown in the Appendix are as follows:

- **Chemistry patents:** Organic fine chemistry; Biotechnology; Pharmaceuticals; Macromolecular chemistry, polymers; Food chemistry; Basic materials chemistry; Materials, metallurgy; Surface technology, coating; Micro-structure & nanotechnology; Chemical engineering; Environmental technology
- **Electrical engineering patents:** Electrical machinery, apparatus, energy; Audio-visual technology; Telecommunications; Digital communications; Basic communication processes; Computer technology; IT methods for management; Semiconductors
- **Instruments patents:** Optics; Measurement; Analysis of biological materials; Control; Medical technology
- **Mechanical engineering patents:** Handling; Machine tools; Engines, pumps, turbines; Textile & paper machines; Other special machines; Thermal processes & apparatus; Mechanical elements; Transport
- **Other patents:** Furniture, games; Other consumer goods; Civil engineering

III. Economic activity in relevant industries

This section presents selected statistics of firm-level data that might be relevant in thinking about opportunities for research driven innovation in industry. The data come from a

combination of the 2004-2014 Statistics NZ R&D Survey, the 2005-2015 Statistics NZ Business Operations Survey; and administrative data from the Longitudinal Business Database (LBD). Presented industries are those with the clearest links to the physical sciences and engineering; at the broadest level we focus on agriculture, mining, manufacturing, information media, professional services, and health care.

We present here those industries whose firms exhibit particularly high or particularly low levels of R&D intensity; engagement with CRIs and universities; the proportion of R&D that is basic; the proportion of funding that is external; proportion of firms reporting any innovation; and measures of the emergence of the industry. Appendix II presents these same measures for all relevant industry subgroups.

A. Industries with significant firm-level R&D

Tables 1 and 2 are intended to highlight industries with firms engaged in significant research activity. Table 1 presents those industries with the highest average R&D per firm, and Table 2 shows those with the highest R&D and a percentage of firm revenues. In both cases, the high numbers for 'Scientific Research Services' are distorted by the fact that Statistics New Zealand treats the CRIs as firms for the purpose of statistical reporting. Putting aside that anomaly, the industries shown by the Tables to have the most significant firm-level R&D activity are:

- Computer systems design
- Comp & electr equip manufacture
- Prof & science equip manufacture
- Engineering design & consulting services
- Scientific testing & analysis services

These represent industries whose firms perform significant research in many countries. Perhaps what is most interesting about this list is the sectors that are not present. In particular, the pharmaceutical and other high-value chemical sectors that are major research performers in other countries are not prominent in New Zealand.

Table 1: Industries with greatest absolute amount of R&D spending

Industry	R&D intensity (percent of revenue)	R&D intensity among performers	R&D intensity among personnel	Personnel intensity among performers	Average yearly R&D (\$m)
Scientific research serv	45%	66%	59%	62%	653.5
Computer systems design	4%	26%	13%	52%	180.5
Comp & electr equip manuf	9%	13%	22%	31%	78.4
Food product manuf	0%	0%	1%	2%	70.2
Prof & science equip manuf	7%	10%	17%	25%	51.3
Engineering design & consulting serv	1%	8%	5%	27%	27.5
Scientific testing & analysis serv	5%	16%	9%	27%	22.6
Domestic appliance manuf	3%	3%	13%	15%	22
Polymer & rubber manuf	1%	1%	2%	5%	20.1
Hospitals	0%	0%	1%	1%	17.7

Table 2: Industries with highest R&D intensity firms

Industry	R&D intensity (percent of revenue)	R&D intensity among performers	R&D intensity among personnel	Personnel intensity among performers	Average yearly R&D (\$m)
Scientific research serv	45%	66%	59%	62%	653.5
Computer systems design	4%	26%	13%	52%	180.5
Scientific testing & analysis serv	5%	16%	9%	27%	22.6
Comp & electr equip manuf	9%	13%	22%	31%	78.4
Prof & science equip manuf	7%	10%	17%	25%	51.3
Engineering design & consulting serv	1%	8%	5%	27%	27.5
Motion picture & sound	1%	7%	4%	75%	9.2
Social assistance services	0%	7%	0%	5%	2.9
Chemical manuf	1%	6%	12%	37%	1.1
Aquaculture	1%	6%	2%	10%	0.6

Extract from Appendix II. Shaded industries are level 3 or 4 ANZSIC 2006 categories; unshaded are level 2. Note that the industry 'scientific research services' includes CRIs.

B. Engagement of firms with public research entities

Statistics New Zealand's R&D Survey asks firms a series of questions about their engagement with other entities in research. It is difficult to know exactly how the firms interpret these questions, and hence difficult to know exactly how to interpret the answers.

We present some illustrative summary statistics to be thought-provoking more than as conveying any reliable truths about the sectors. Table 3 shows those industries whose firms report the highest and lowest levels of overall engagement, along with some indicative answers regarding reasons for not engaging more.

A number of chemical-based industries—which did not report high levels of internal R&D—are among the heavier engagers with CRIs and universities. The industries that report low levels of engagement are generally not surprising, and their primary reason for not engaging is that they do not perceive a need. The only exception is aquaculture, for which 73% of firms report that they do not engage because the universities and CRIs do not have the relevant expertise.

Table 3: Industries with highest & lowest rates of engagement with CRIs & universities

Industry	Reasons for not engaging more				
	Any engagement with CRI or uni	No need to engage more with CRIs/uni	Didn't know how to contact CRIs/uni to engage more	Not enough expertise in CRIs/uni to engage more	Too expensive to engage more with CRIs/uni
Chemical manuf	65%	36%	0%	24%	19%
Scientific research serv	51%	35%	5%	18%	16%
Non-metallic mining	48%	95%	2%	1%	1%
Fishing & hunting	45%	40%	14%	6%	6%
Scientific testing & analysis serv	43%	49%	8%	30%	23%
Basic polymer manuf	40%	25%	3%	2%	65%
Domestic appliance manuf	37%	40%	25%	0%	17%
Comp & electr equip manuf	32%	36%	14%	25%	31%
Pharma & med product manuf	31%	58%	13%	8%	20%
Fertiliser & pesticide manuf	30%	49%	4%	4%	40%
Printing	5%	79%	28%	15%	0%
Aquaculture	4%	15%	3%	73%	7%
Transport equip manuf	4%	57%	11%	18%	7%
Telecom services	4%	90%	3%	47%	1%
Medical care services	2%	72%	15%	8%	3%
Hospitals	2%	71%	1%	1%	0%
Broadcasting (excl internet)	2%	94%	0%	0%	0%
Residential care services	1%	71%	11%	17%	1%
Library & other info services	0%	100%	0%	0%	0%
Pathology & diagnostic imaging serv	0%	43%	0%	42%	0%

Extract from Appendix II. Shaded industries are level 3 or 4 ANZSIC06 categories; unshaded are level 2.

C. Basic Research

Table 4 displays the industries with the highest and lowest average reported proportion of basic research. 'Pathology and diagnostic imaging services' and 'Agriculture support services' both average over one-third of R&D spending on basic research. Note that these are not industries where the overall level of R&D is high, and we do not know how the firms implement the definition of basic research.

Table 4: Industries with highest & lowest proportions of R&D deemed "basic"

Industry	Prop. of R&D spending that is applied	Prop. of R&D spending that is experimental	Prop. of R&D spending that is basic research
Pathology & diagnostic imaging serv	50%	0%	50%
Agr support services	17%	50%	34%
Motion picture & sound	27%	54%	20%
Telecom services	33%	42%	19%
Residential care services	22%	60%	19%
Scientific testing & analysis serv	44%	42%	13%
Hospitals	51%	18%	13%
Social assistance services	15%	18%	13%
Forestry & logging	39%	49%	12%
Transport equip manuf	23%	65%	11%
Non-metallic mining	6%	91%	3%
Basic polymer manuf	34%	63%	3%
Domestic appliance manuf	22%	76%	2%
Specialised machinery & equip manuf	29%	69%	2%
Petrol & coal product	16%	83%	1%
Cleaning compound & toiletry prep manuf	41%	58%	1%
Printing	4%	10%	1%
Fishing & hunting	0%	100%	0%
Metal ore mining	63%	37%	0%
Library & other info services	25%	75%	0%

Extract from Appendix II. Shaded industries are level 3 or 4 ANZSIC 2006 categories; unshaded are level 2.

D. Reported innovation rates

Statistics New Zealand's Business Operations Survey ('BOS') asks firms every other year about their innovative activity. Table 5 shows those industries with the highest and lowest reported rates of innovation. The industries whose firms have the highest self-reported innovation rates have significant overlap with those reporting high levels of R&D above, but there are also some other industries that have high innovation rates in other countries, such as Pharmaceuticals and medical products. Library and other information services reports high innovation but no R&D, so is presumably innovating in ways not derived from science and engineering.

Table 5: Industries with highest & lowest proportions of firms that report having innovated in the last year

Industry	Percent of firms that report...				
	Any innovation in last yr	Undertook or funded R&D in last yr	Entered new export mkt in last yr	Protects IP in any way	Exports as % of sales in last yr
Library & other info services	100%	0%	0%	77%	2%
Comp & electr equip manuf	69%	49%	32%	81%	36%
ISPs & other info services	69%	28%	9%	89%	9%
Telecom services	63%	18%	5%	73%	4%
Prof & science equip manuf	62%	46%	32%	77%	47%
Computer systems design	62%	36%	16%	91%	19%
Pharma & med product manuf	62%	51%	17%	89%	44%
Electrical equip manuf	61%	38%	17%	74%	18%
Fertiliser & pesticide manuf	60%	55%	20%	98%	7%
Specialised machinery & equip manuf	59%	35%	20%	68%	20%
Hospitals	34%	4%	0%	35%	0%
Residential care services	34%	2%	0%	33%	0%
Coal mining	31%	10%	4%	55%	8%
Scientific research serv	31%	42%	18%	44%	50%
Fishing & hunting	31%	16%	16%	37%	21%
Non-metallic mining	29%	8%	2%	38%	3%
Agr support services	28%	4%	1%	21%	3%
Agriculture	26%	8%	5%	25%	31%
Forestry & logging	25%	6%	2%	13%	7%
Metal ore mining	21%	13%	2%	30%	25%

Extract from Appendix II. Shaded industries are level 3 or 4 ANZSIC 2006 categories; unshaded are level 2.

E. Indicators of emergent industries

Two indicators of emergent industries are the proportion of relatively young firms, and the overall growth rate of the industry. Table 6 shows the industries that have the largest proportion of firms two years old or younger, using the Longitudinal Business Data. Table 7 shows the fastest growing industries. Industries that are both fast-growing and have a high proportion of new firms:

- Internet publishing & broadcasting
- Metal ore mining
- Computer systems design
- Engineering design & consulting services

Note that the first two of these are very small industries with 40 firms or fewer in the LBD. The other two are much larger, making their relatively fast growth and number of new firms particularly impressive.

Table 6: Industries with highest proportions of new firms

Industry	Proportion of firms 2 yrs or younger	% change in sales, 2005-2015	Average no. of firms in a year
Internet publishing & broadcasting	0.42	2482	37
Telecom services	0.37	14	136
Exploration & mining services	0.34	6	85
Metal ore mining	0.30	264	40
ISPs & data processing	0.29	-15	250
Food products	0.24	22	2,049
Basic polymers	0.24	-45	37
Domestic appliances	0.23	-45	35
Computer systems design	0.21	52	3,001
Engineering design & consulting services	0.21	53	1,630

Extract from Appendix II. Shaded industries are level 3 or 4 ANZSIC 2006 categories; unshaded are level 2. The average number of firms in a year is calculated over the 2010-2015 financial years. The proportion of firms 2 years or younger is calculated over all firm-year observations over 2010-2015.

Table 7: Fastest growing industries

Industry	Proportion of firms 2 yrs or younger	% change in sales, 2005-2015	Average no. of firms in a year
Internet publishing & broadcasting	0.42	2482	37
Oil & gas extraction	0.10	473	9
Metal ore mining	0.30	264	40
Pharma & med products	0.13	66	81
Residential care services	0.09	55	766
Engineering design & consulting services	0.21	53	1,630
Medical care services	0.13	52	6,043
Computer systems design	0.21	52	3,001
Hospitals	0.06	43	99
Forestry & logging	0.19	37	659

Extract from Appendix II. Shaded industries are level 3 or 4 ANZSIC 2006 categories; unshaded are level 2. The average number of firms in a year is calculated over the 2010-2015 financial years. The proportion of firms 2 years or younger is calculated over all firm-year observations over 2010-2015.

Appendix II contains a more complete listing of the firm-level economic statistics. The finer industries we present statistics on are:

- **Agriculture, Forestry & Fishing:** Agriculture; Aquaculture; Forestry & logging; Fishing & hunting; Agricultural support services
- **Mining²:** Coal mining; Metal ore mining; Non-metallic mining
- **Manufacturing:** Food product manuf; Beverage & tobacco manuf; Textile manuf; Wood product manuf; Pulp & paper manuf; Printing; Petrol & coal product manuf; Basic chemical manuf (*and within: Chemical manuf; Basic polymer manuf; Fertiliser & pesticide manuf; Pharma & med product manuf; Cleaning compound & toiletry prep manuf; Other chemical product manuf*); Polymer & rubber product manuf; Non-metallic product manuf; Metal product manuf; Fabricated metal product manuf; Transport equipment manuf; Machinery & equipment manuf (*and within: Professional & scientific equipment manuf; Computer & electronic equipment manuf; Electric equipment manuf; Domestic appliance manuf; Pump, compressor, heating & ventilation manuf; Specialised machinery & equipment manuf; Other machinery & equipment manuf*); Furniture & other manuf
- **Information media & telecommunications:** Publishing (excluding internet & music); Motion picture & sound; Broadcasting (excluding internet); Telecom services; ISPs & other info services; Library & other info services

² We do not present statistics on the level 2 mining industries 'Oil and gas extraction', nor 'Exploration and other mining support services'. This is because of the very low number of firms in these industries appearing in the R&D surveys.

- **Professional, scientific & technical services:** Professional & technical services (*and within: Scientific research services; Engineering design & consulting services; Scientific testing & analysis services*); Computer systems design
- **Health care & social assistance:** Hospitals; Medical care services (*and within: Pathology & diagnostic imaging services*); Residential care services; Social assistance services

Research and Commercial Innovation in New Zealand: Background Report for SfTI Industry-Led Discussions

Appendix I

Motu Economic and Public Policy Research

April 2017

Adam Jaffe

Motu Economic and Public Policy Research and Queensland University of Technology
adam.jaffe@motu.org.nz

Nathan Chappell

Motu Economic and Public Policy Research
nathan.chappell@motu.org.nz

Contents

I.	Introduction to appendix figures	3
II.	Research output of NZ universities and CRIs	5
III.	Triadic patent applications, NZ and other countries	31

Figures

Figure 1:	Chemistry research output by narrow subject area.....	5
Figure 2:	Chemical engineering research output by narrow subject area	8
Figure 3:	Earth science research output by narrow subject area.....	11
Figure 4:	Energy science research output by narrow subject area	16
Figure 5:	Engineering research output by narrow subject area	18
Figure 6:	Materials science research output by narrow subject area.....	24
Figure 7:	Physics & astronomy research output by narrow subject area	27
Figure 8:	Chemistry patents, NZ & other countries	31
Figure 9:	Electrical engineering patents, NZ & other countries	36
Figure 10:	Instruments patents, NZ & other countries.....	40
Figure 11:	Mechanical engineering patents, NZ & other countries	42
Figure 12:	Other patents, NZ & other countries	46

I. Introduction to appendix figures

These appendix figures supplement the main report by presenting more detailed figures on i) the research output of NZ universities and Crown Research Institutes (CRIs) and ii) NZ's triadic patenting rates (patents filed in the US, Japan and Europe).

Below we list the finer subject areas of research output presented in this appendix:

- **Chemistry:** Analytical Chemistry; Chemistry (misc.); Electrochemistry; General Chemistry; Inorganic Chemistry; Physical & Theoretical Chemistry; Spectroscopy
- **Chemical Engineering:** Bioengineering; Catalysis; Chemical Engineering (misc.); Chemical Health & Safety; Colloid & Surface Chemistry; Filtration & Separation; Fluid Flow & Transfer Processes; General Chemical Engineering; Process Chemistry & Technology
- **Earth & Planetary Sciences:** Atmospheric Science; Computers in Earth Sciences; Earth & Planetary Sciences (misc.); Earth-Surface Processes; Economic Geology; General Earth & Planetary Sciences; Geochemistry & Petrology; Geology; Geophysics; Geotechnical Engineering & Engineering Geology; Geology; Oceanography; Paleontology; Space & Planetary Science; Stratigraphy
- **Energy:** Energy (misc.); Energy Engineering & Power Technology; Fuel Technology; General Energy; Nuclear Energy & Engineering; Renewable Energy, Sustainability & the Environment
- **Engineering:** Aerospace Engineering; Architecture; Automotive Engineering; Biomedical Engineering; Building & Construction; Civil & Structural Engineering; Computational Mechanics; Control & Systems Engineering; Electrical & Electronic Engineering; Engineering (misc.); General Engineering; Industrial & Manufacturing Engineering; Mechanical Engineering; Mechanics of Materials; Media Technology; Ocean Engineering; Safety, Risk, Reliability & Quality
- **Materials Science:** Biomaterials; Ceramics & Composites; Electronic, Optical & Magnetic Materials; General Materials Science; Materials Chemistry; Materials Science (misc.); Metals & Alloys; Polymers & Plastics; Surfaces, Coatings & Films
- **Physics & Astronomy:** Acoustics & Ultrasonics; Astronomy & Astrophysics; Atomic & Molecular Physics, and Optics; Condensed Matter Physics; General Physics & Astronomy; Instrumentation; Nuclear & High Energy Physics; Physics & Astronomy (misc.); Radiation; Statistical & Nonlinear Physics; Surfaces & Interfaces

Below we list the finer technology areas of patenting presented in this appendix

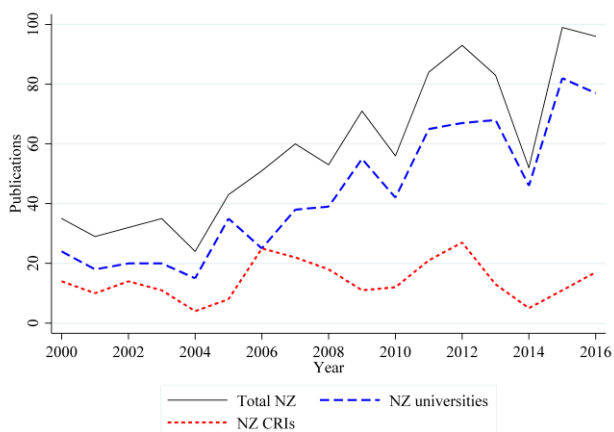
- **Chemistry patents:** Organic fine chemistry; Biotechnology; Pharmaceuticals; Macromolecular chemistry, polymers; Food chemistry; Basic materials chemistry; Materials, metallurgy; Surface technology, coating; Micro-structure & nanotechnology; Chemical engineering; Environmental technology
- **Electrical engineering patents:** Electrical machinery, apparatus, energy; Audio-visual technology; Telecommunications; Digital communications; Basic communication processes; Computer technology; Semiconductors
- **Instruments patents:** Optics; Measurement; Control; Medical technology
- **Mechanical engineering patents:** Handling; Machine tools; Engines, pumps, turbines; Textile & paper machines; Other special machines; Thermal processes & apparatus; Mechanical elements; Transport
- **Other patents:** Furniture, games; Other consumer goods; Civil engineering

II. Research output of NZ universities and CRIs

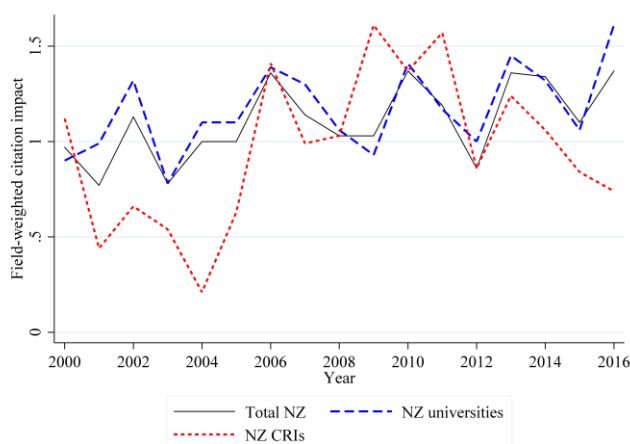
This section measures the research output of NZ universities and CRIs for different narrow subject areas, by looking at the total number of publications and the relative citation impact (the number citations per publication relative to the world average).

Figure 1: Chemistry research output by narrow subject area

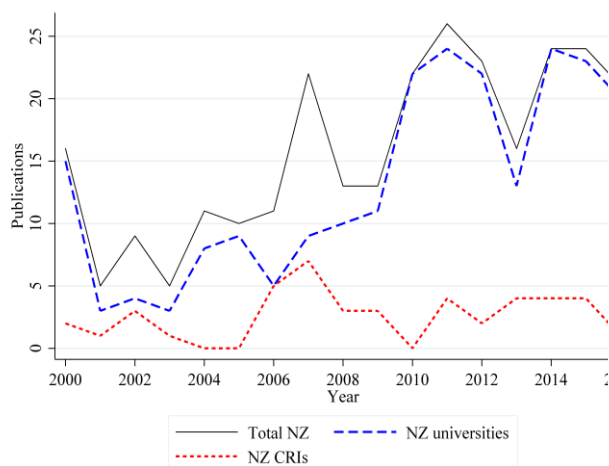
Panel A1: Analytic chem pubs



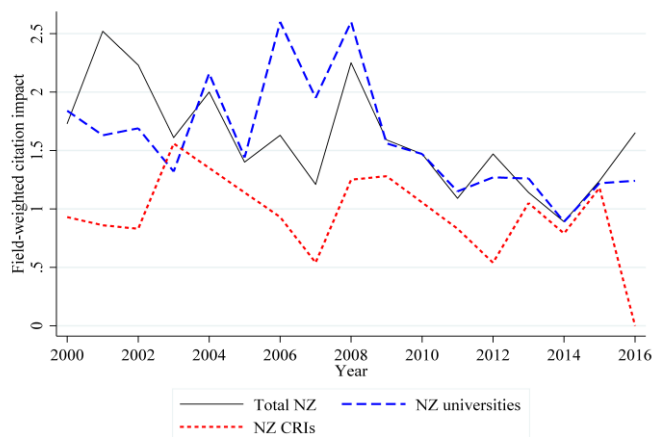
Panel A2: Analytic chem citation impact



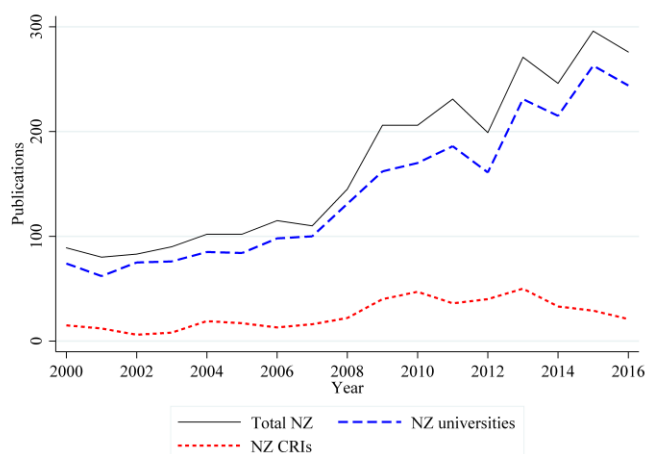
Panel B1: Electrochemistry pubs



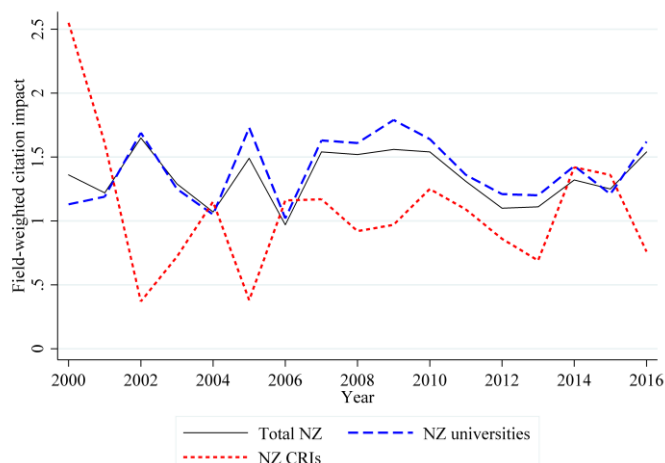
Panel B2: Electrochemistry citation impact



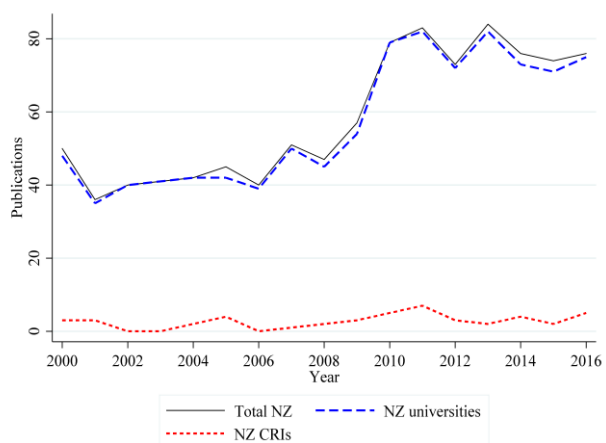
Panel C1: General chem pubs



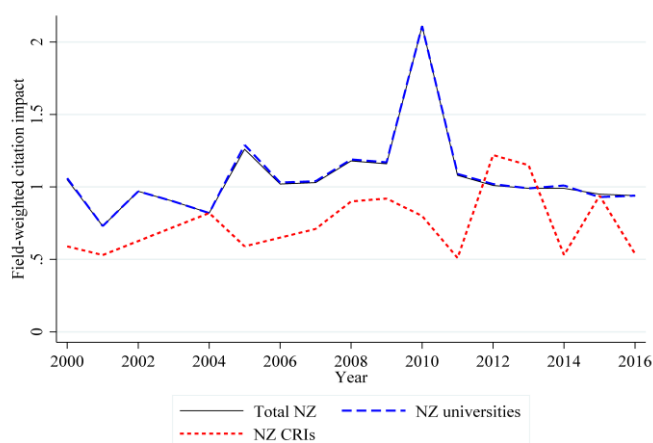
Panel C2: General chem citation impact



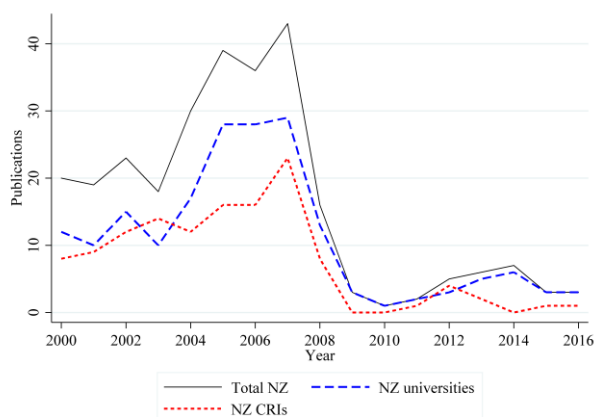
Panel D1: Inorganic chem pubs



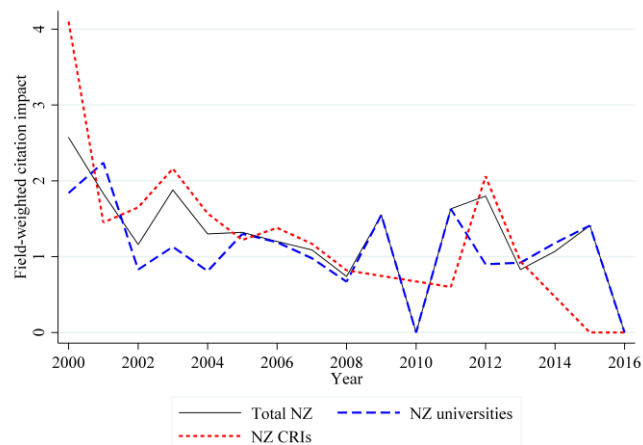
Panel D2: Inorganic chem citation impact



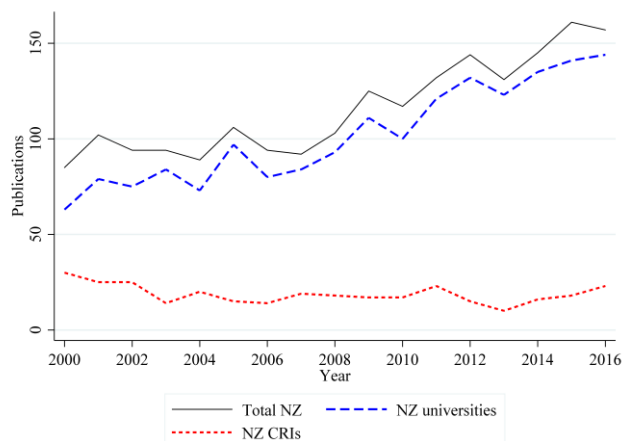
Panel E1: Misc. chem pubs



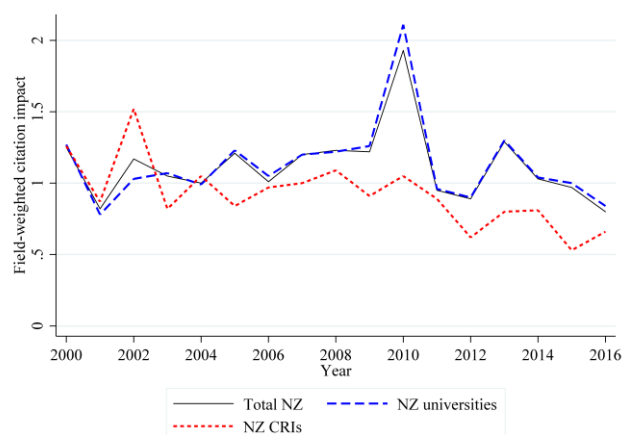
Panel E2: Misc. chem citation impact



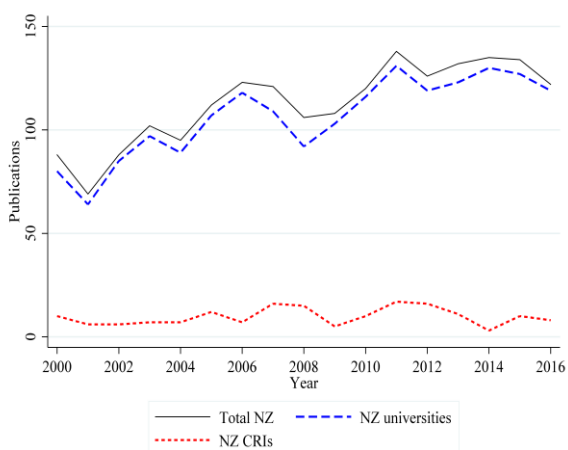
Panel F1: Organic chem pubs



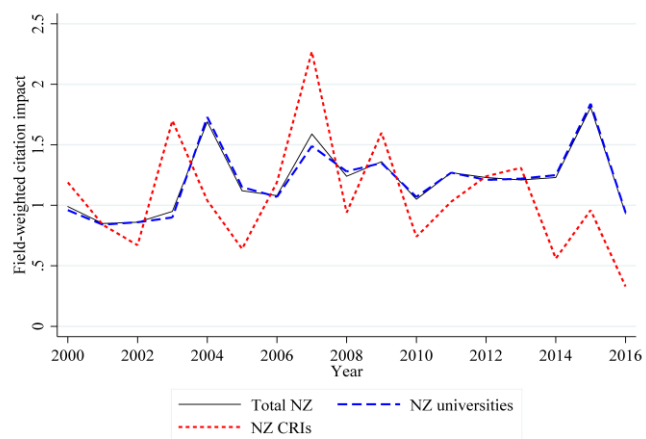
Panel F2: Organic chem citation impact



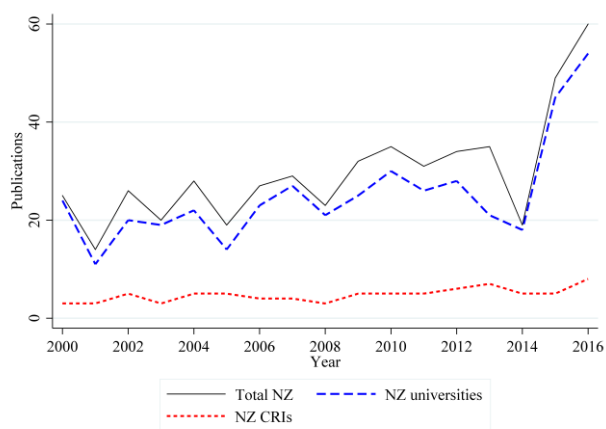
Panel G1: Theoretical chem pubs



Panel G2: Theoretical chem citation impact



Panel H1: Spectroscopy pubs



Panel H2: Spectroscopy citation impact

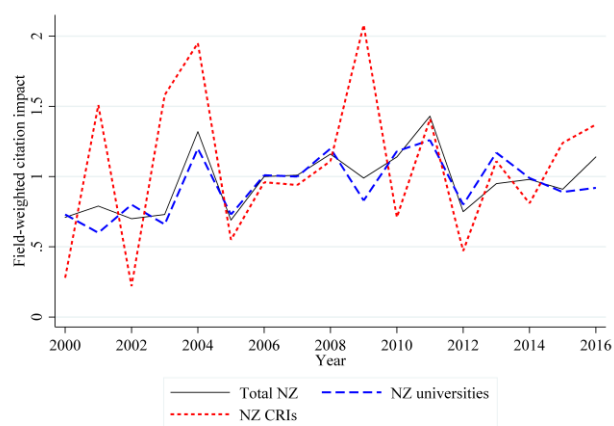
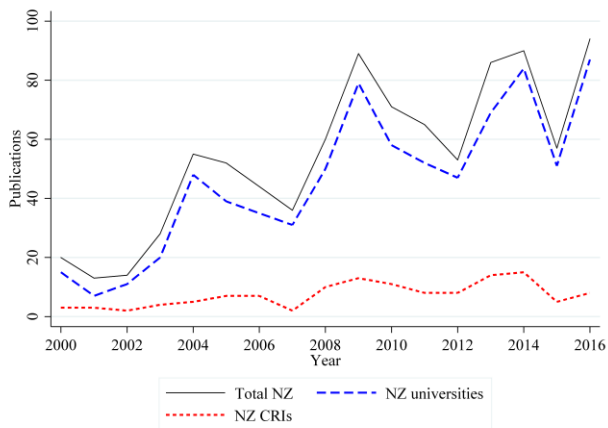
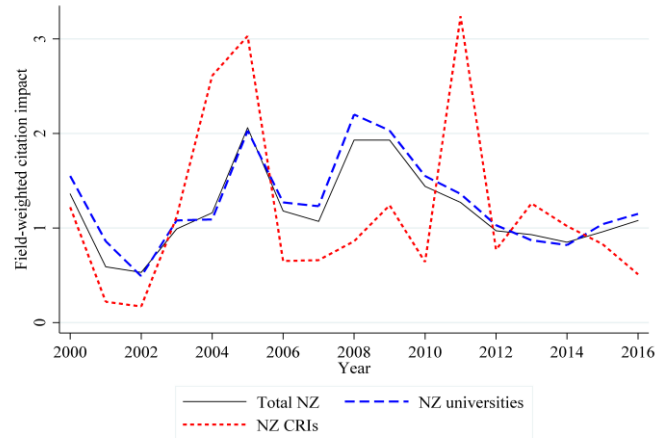


Figure 2: Chemical engineering research output by narrow subject area

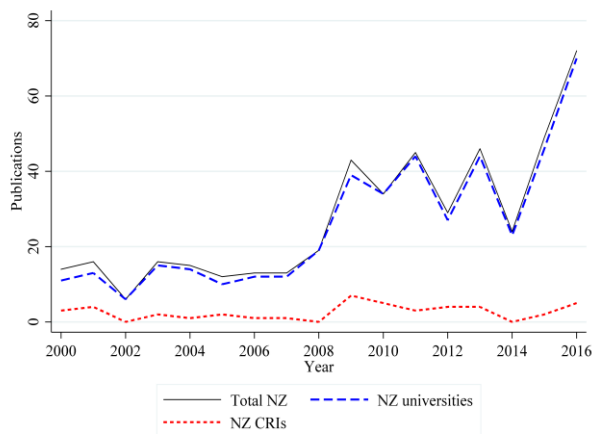
Panel A1: Bioengineering pubs



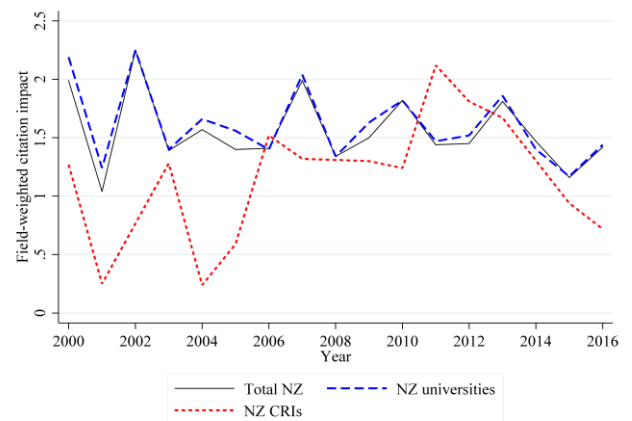
Panel A2: Bioengineering citation impact



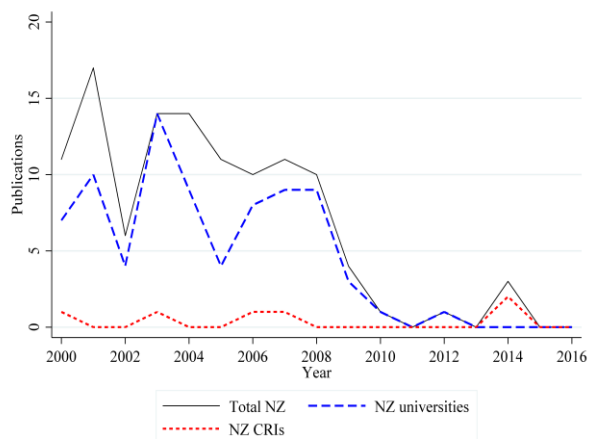
Panel B1: Catalysis pubs



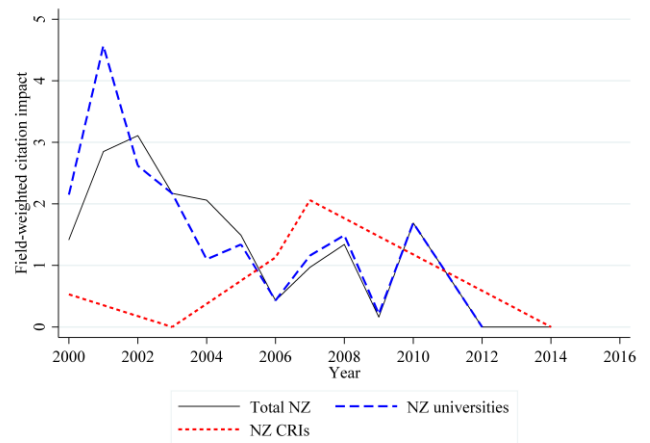
Panel B2: Catalysis citation impact



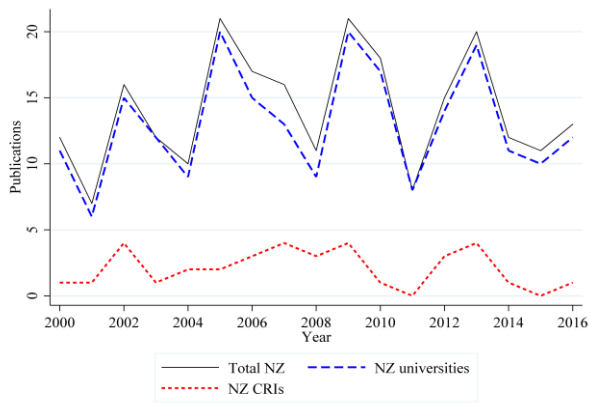
Panel C1: Chemical health pubs



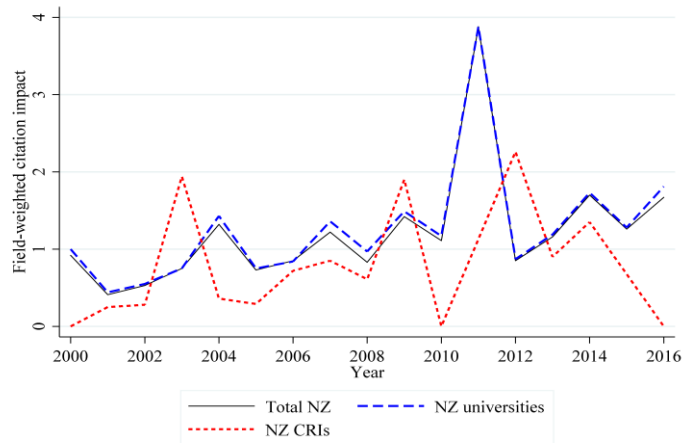
Panel C2: Chemical health citation impact



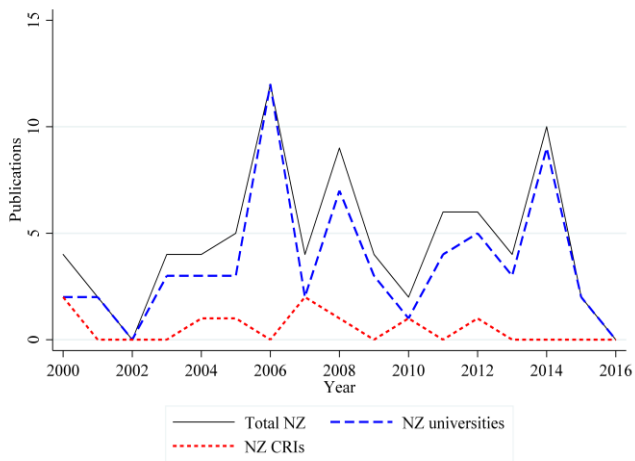
Panel D1: Colloid & surface pubs



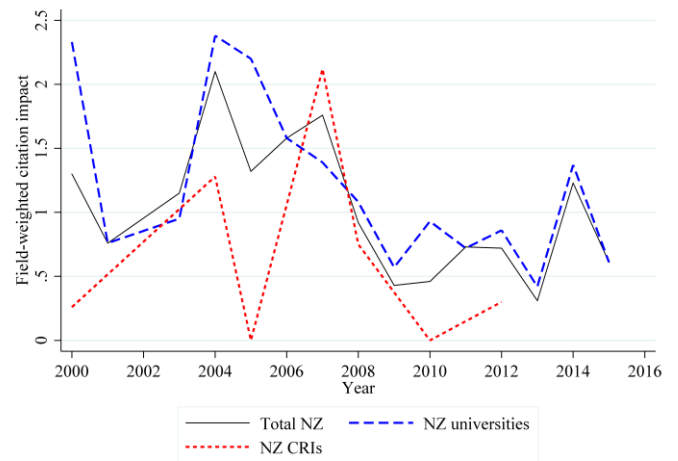
Panel D2: Colloid & surface citation impact



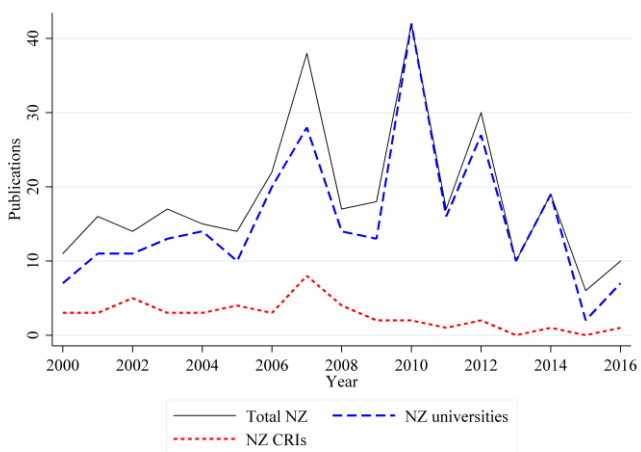
Panel E1: Filtration & separation pubs



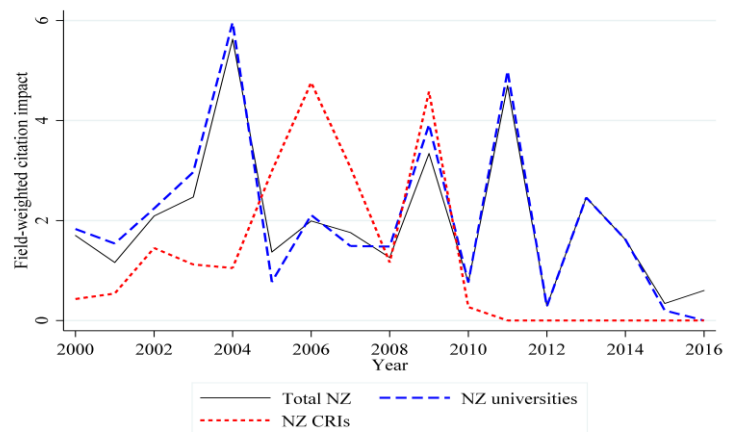
Panel E2: Filtration & separation citation impact



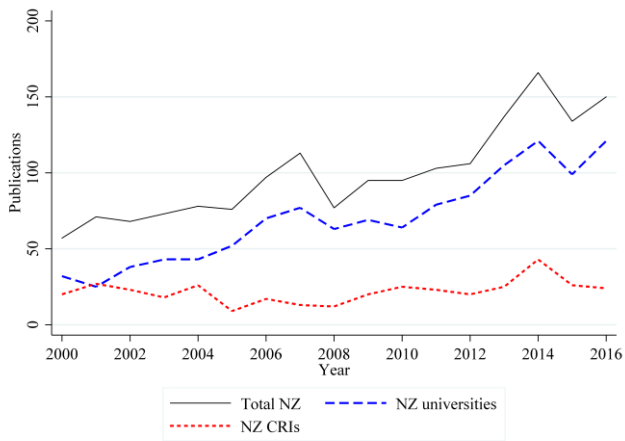
Panel F1: Fluid flow pubs



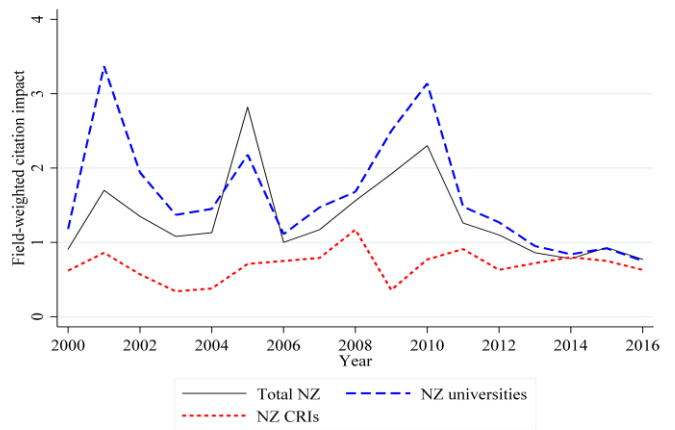
Panel F2: Fluid flow citation impact



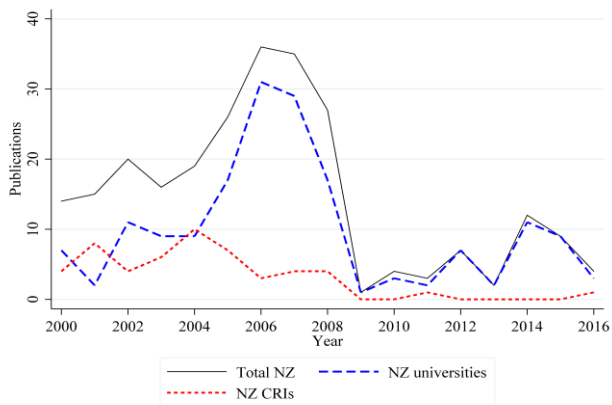
Panel G1: General chem eng pubs



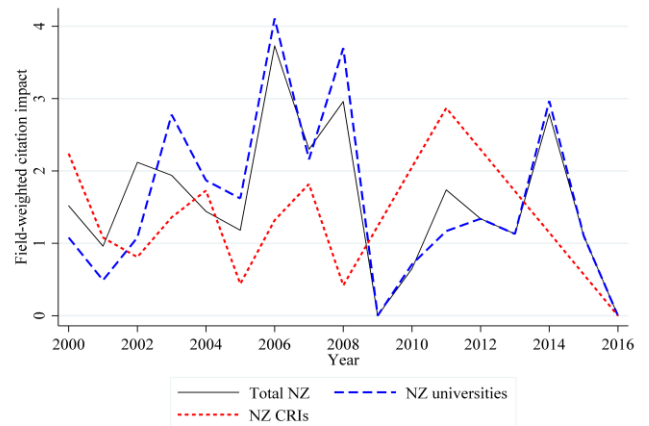
Panel G2: General chem eng citation impact



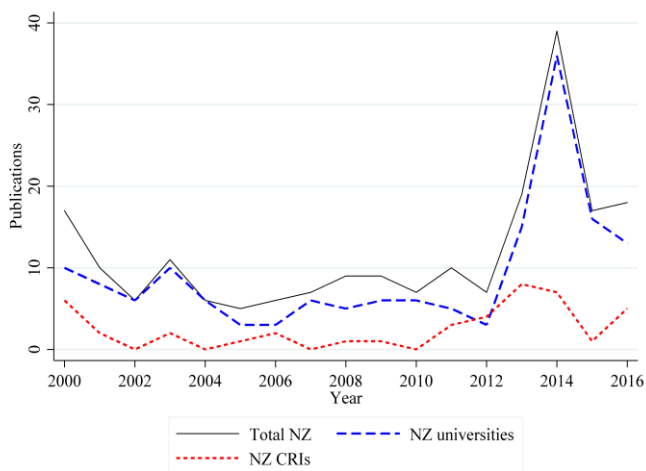
Panel H1: Misc. chem eng pubs



Panel H2: Misc. chem eng citation impact



Panel I1: Process chem pubs



Panel I2: Process chem citation impact

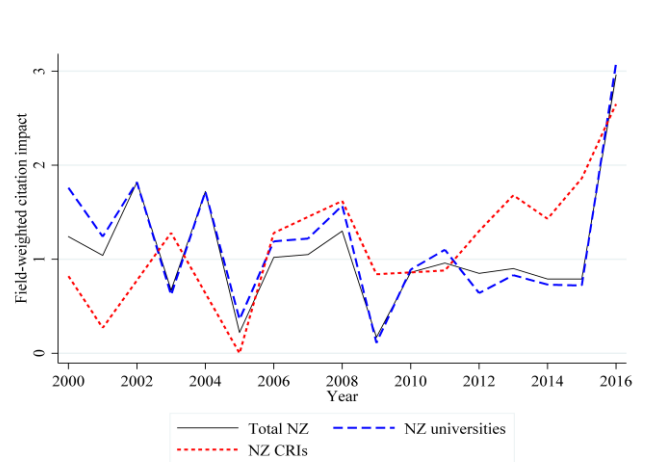
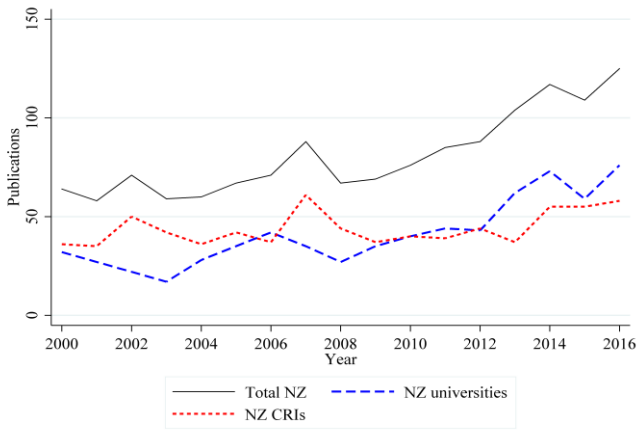
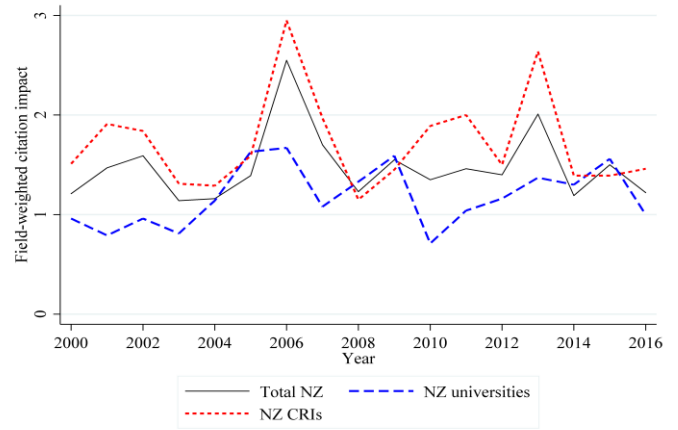


Figure 3: Earth science research output by narrow subject area

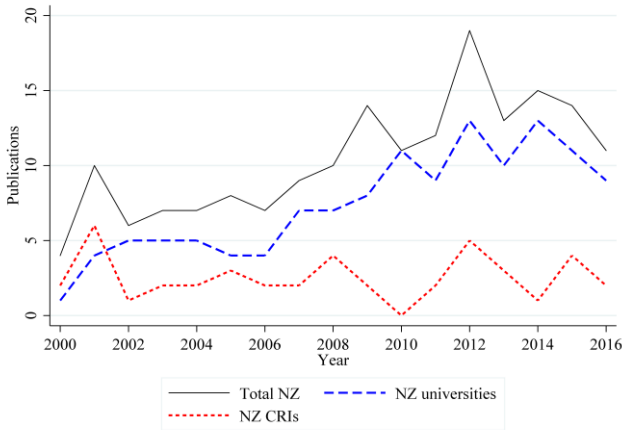
Panel A1: Atmospheric science pubs



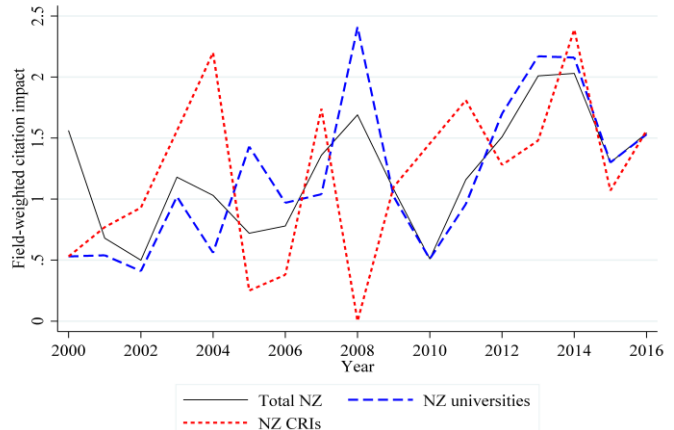
Panel A2: Atmospheric science citation impact



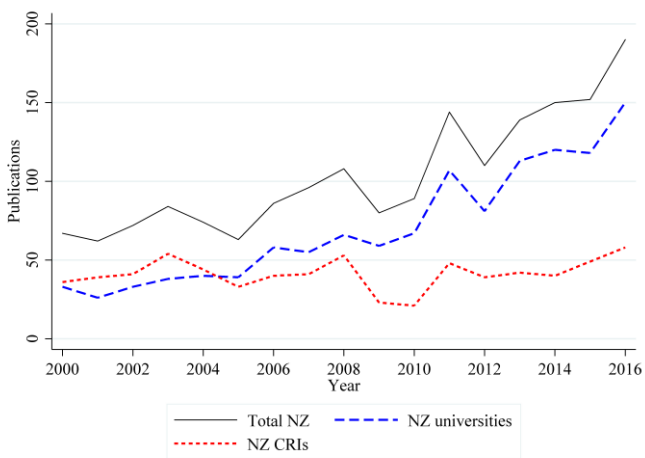
Panel B1: Computers in earth sci pubs



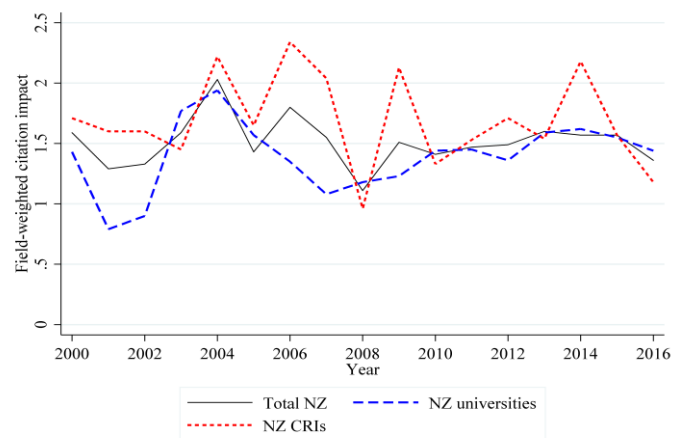
Panel B2: Computers in earth sci citation impact



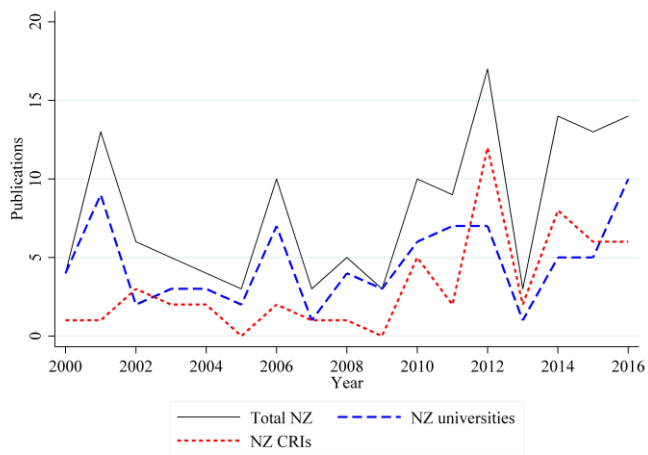
Panel C1: Earth-surface process pubs



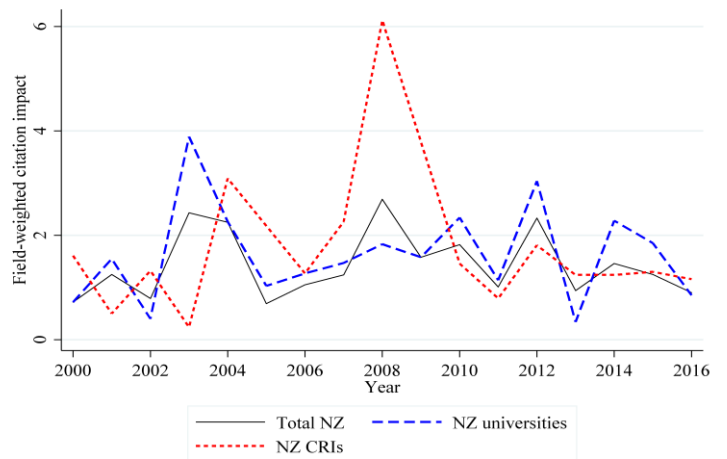
Panel C2: Earth-surface process citation impact



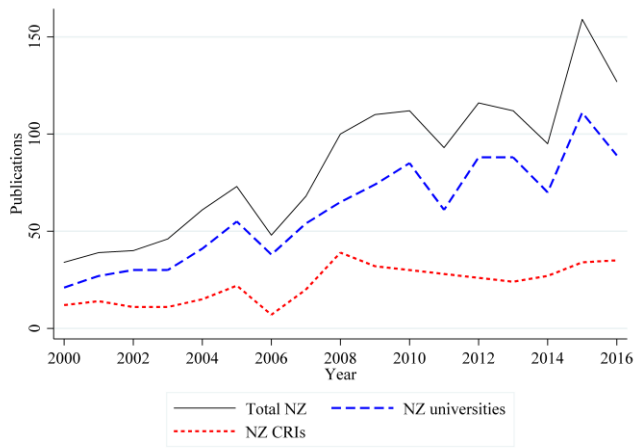
Panel D1: Economic geology pubs



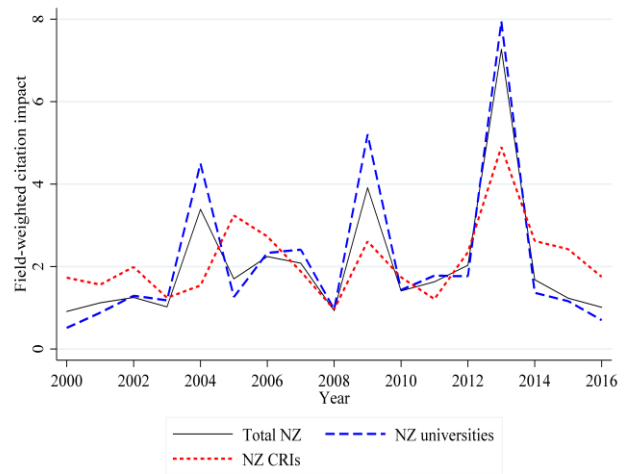
Panel D2: Economic geology citation impact



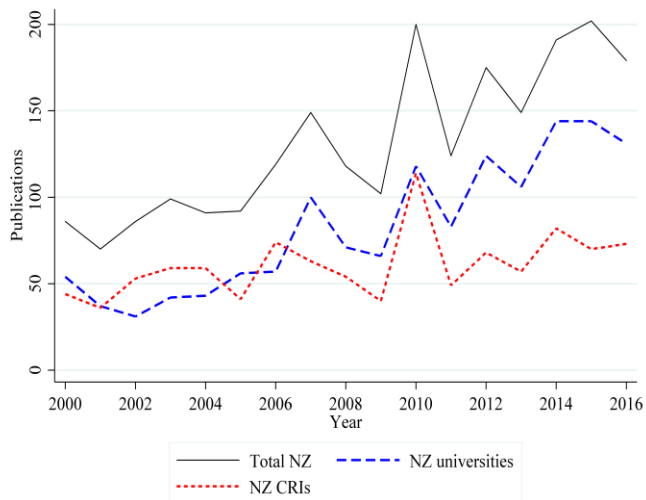
Panel E1: General earth science pubs



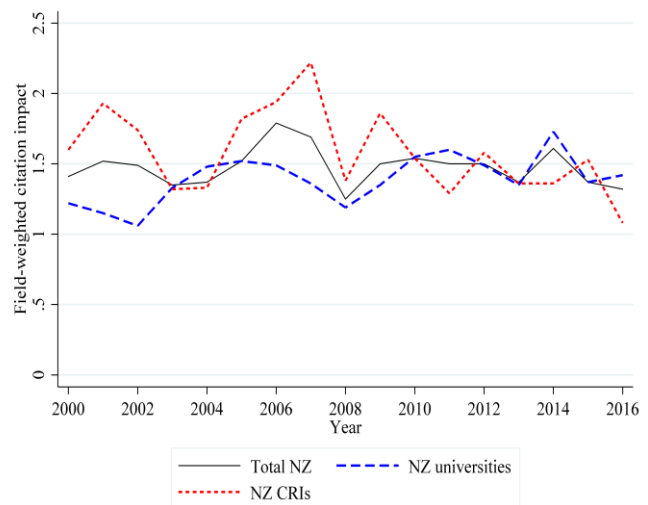
Panel E2: General earth science citation impact



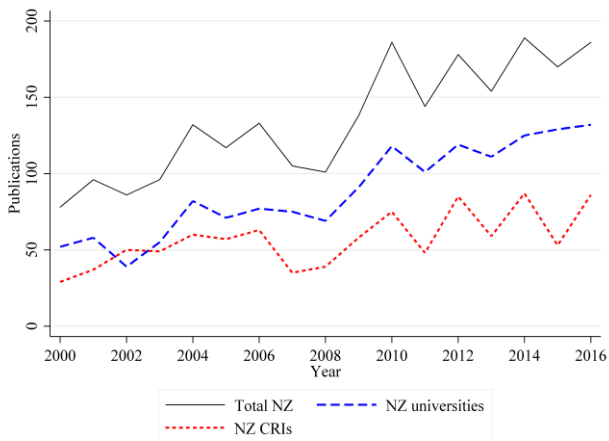
Panel F1: Geochem & petrology pubs



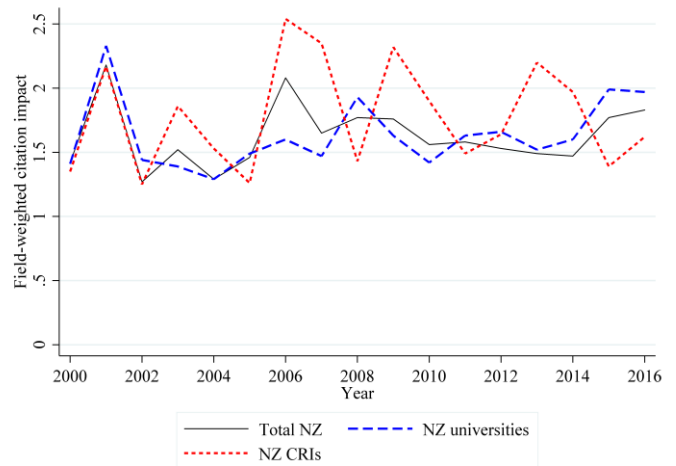
Panel F2: Geochem & petrology citation impact



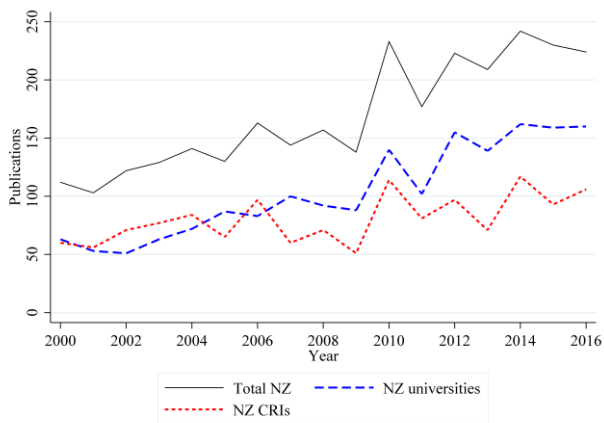
Panel G1: Geology pubs



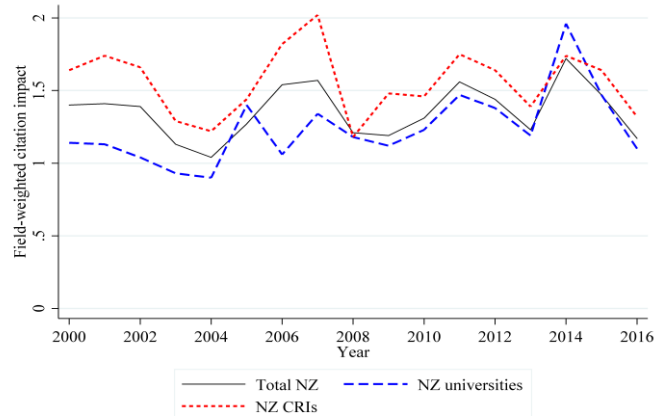
Panel G2: Geology citation impact



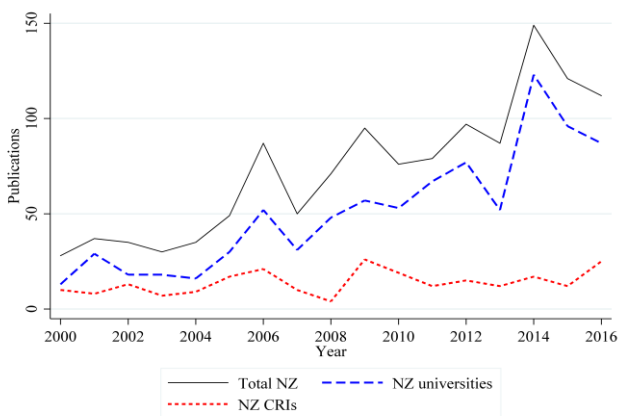
Panel H1: Geophysics pubs



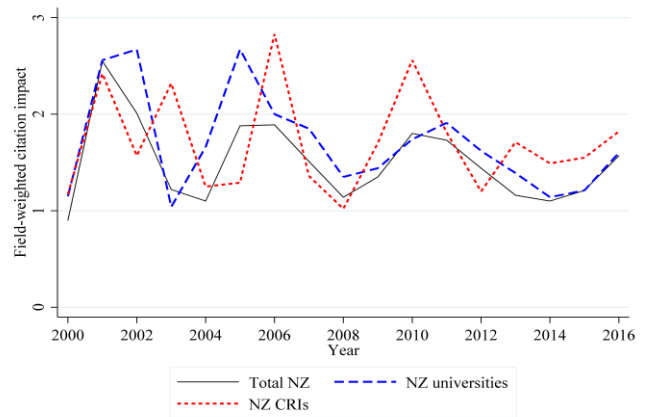
Panel H2: Geophysics citation impact



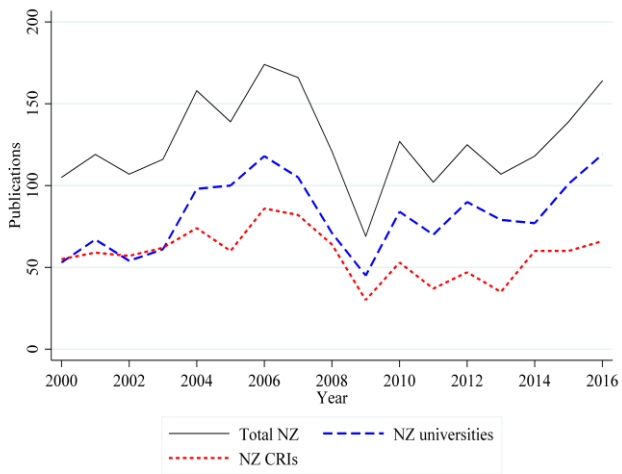
Panel I1: Geotech eng pubs



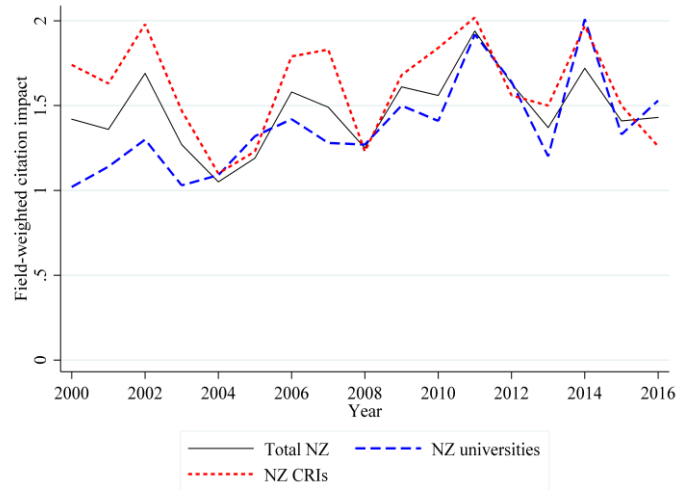
Panel I2: Geotech eng citation impact



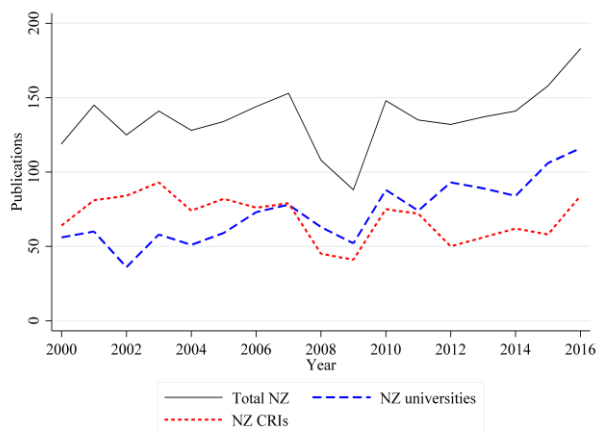
Panel J1: Misc. earth science pubs



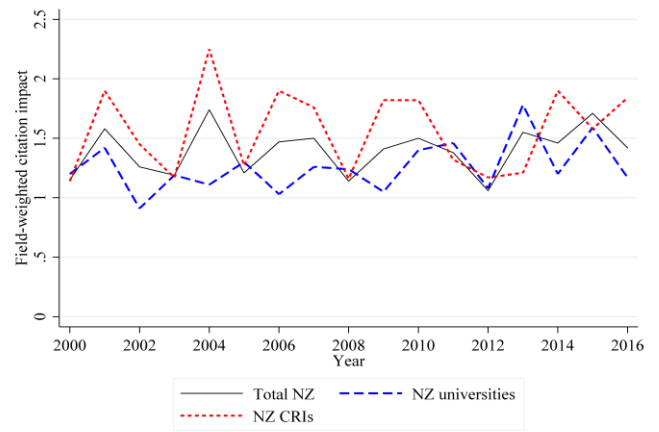
Panel J2: Misc. earth science citation impact



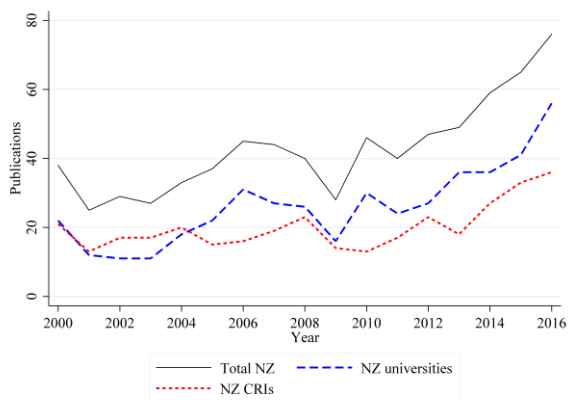
Panel K1: Oceanography pubs



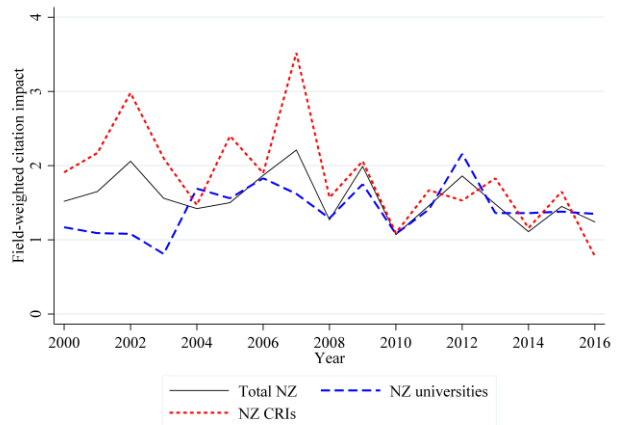
Panel K2: Oceanography citation impact



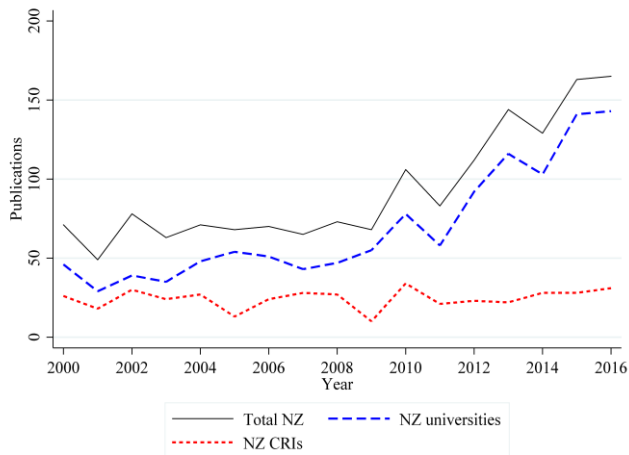
Panel L1: Paleontology pubs



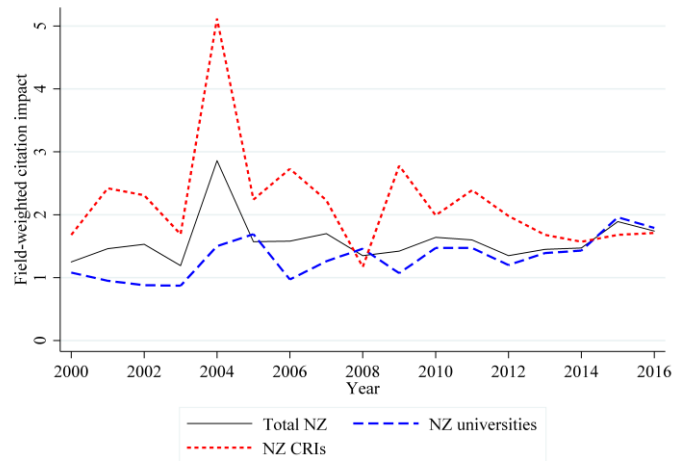
Panel L2: Paleontology citation impact



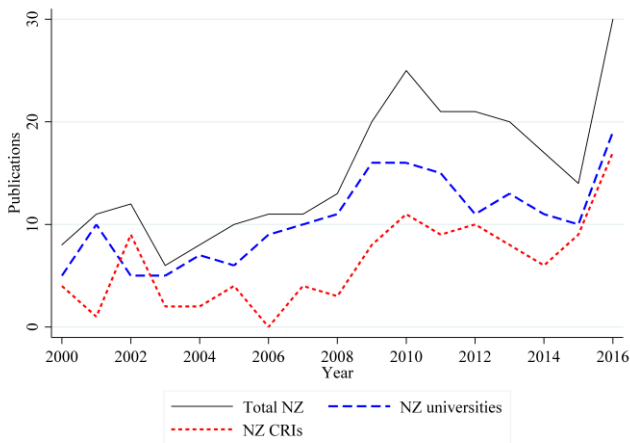
Panel M1: Space & planetary pubs



Panel M2: Space & planetary citation impact



Panel N1: Stratigraphy pubs



Panel N2: Stratigraphy citation impact

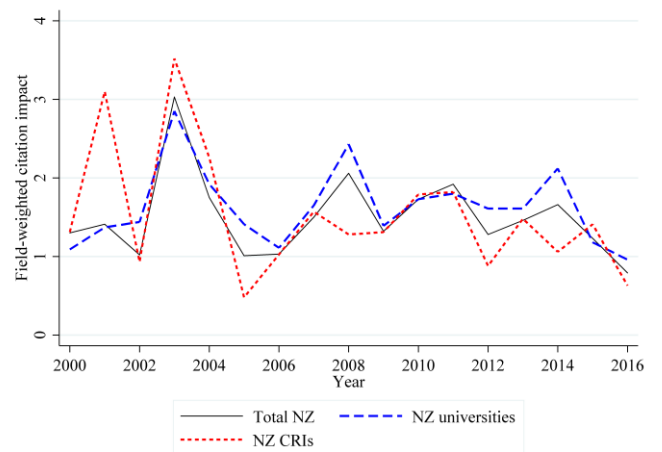
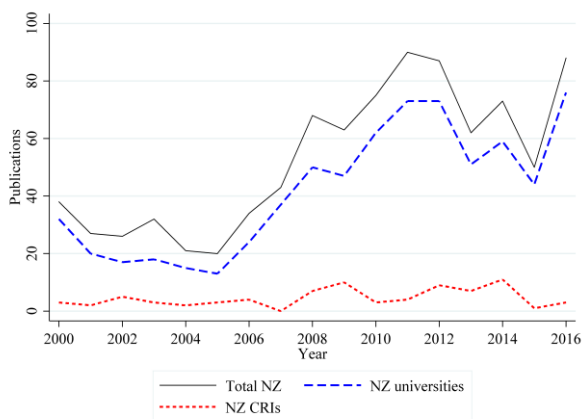
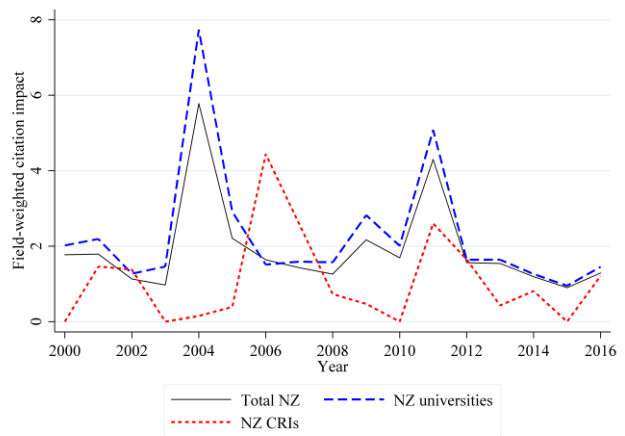


Figure 4: Energy science research output by narrow subject area

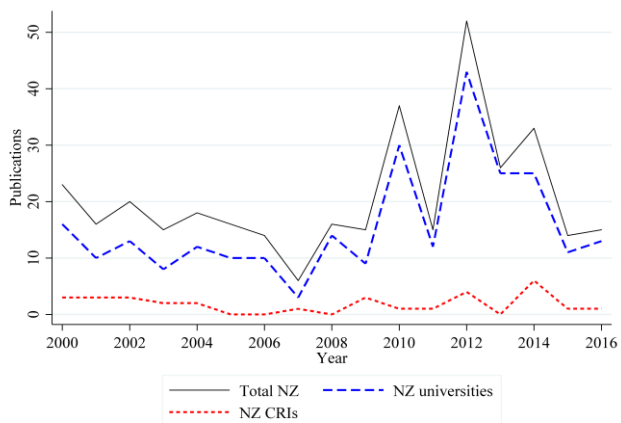
Panel A1: Energy eng pubs



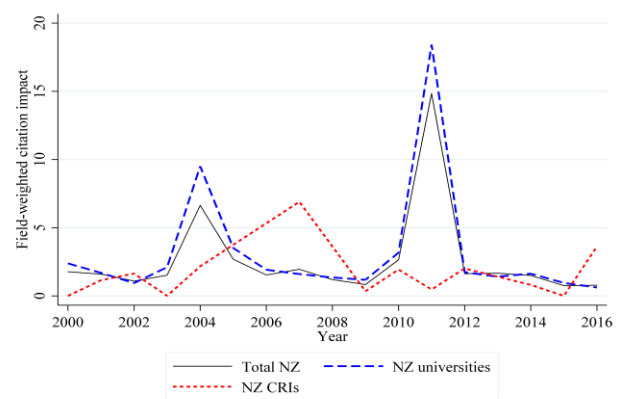
Panel A2: Energy eng citation impact



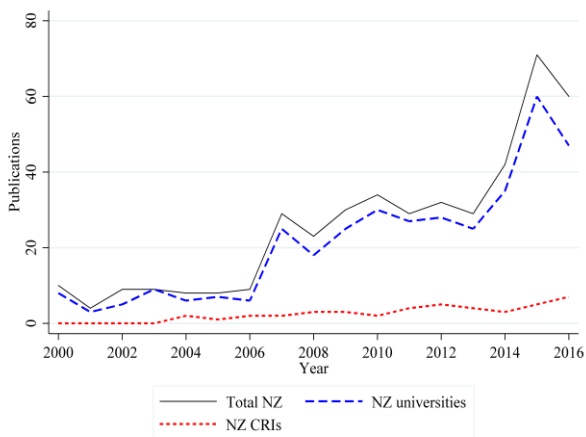
Panel B1: Fuel tech pubs



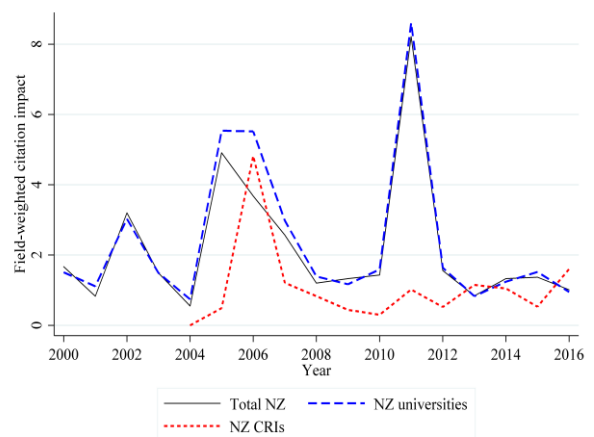
Panel B2: Fuel tech citation impact



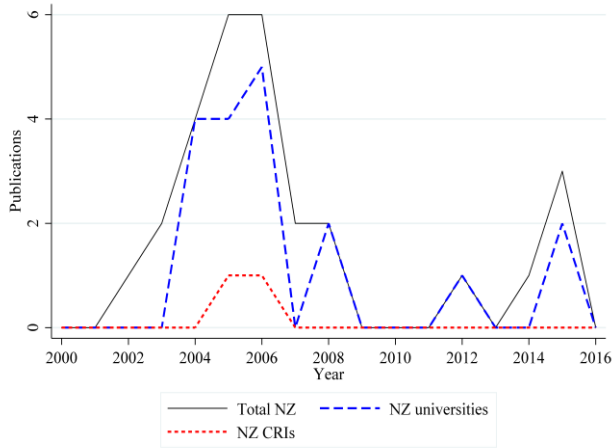
Panel C1: General energy pubs



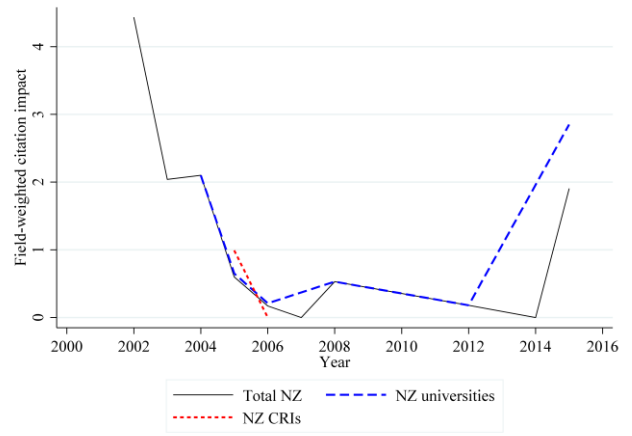
Panel C2: General energy citation impact



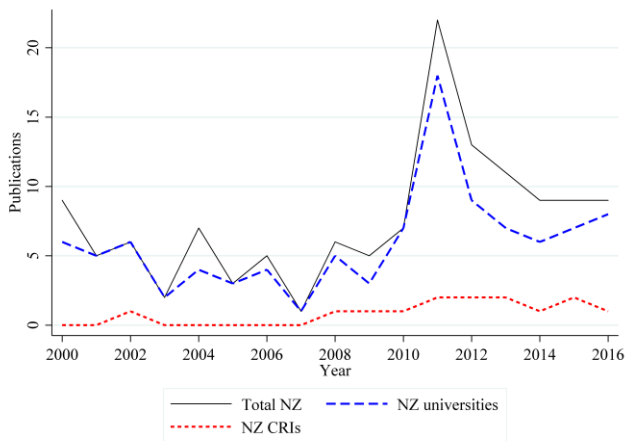
Panel D1: Misc. energy pubs



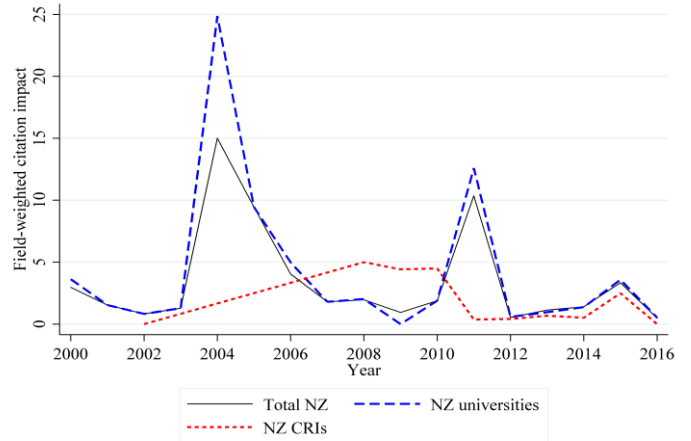
Panel D2: Misc. energy citation impact



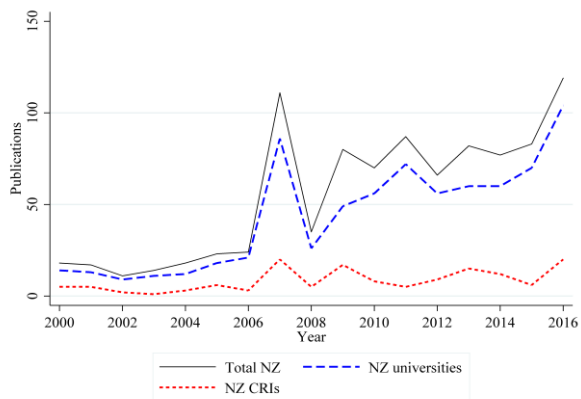
Panel E1: Nuclear energy pubs



Panel E2: Nuclear energy citation impact



Panel F1: Renewable energy pubs



Panel F2: Renewable energy citation impact

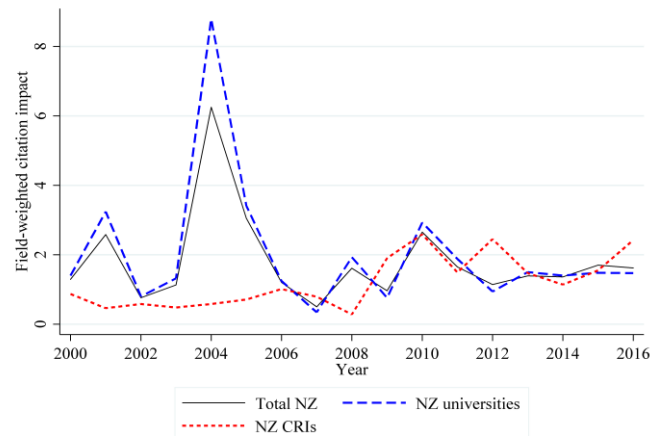
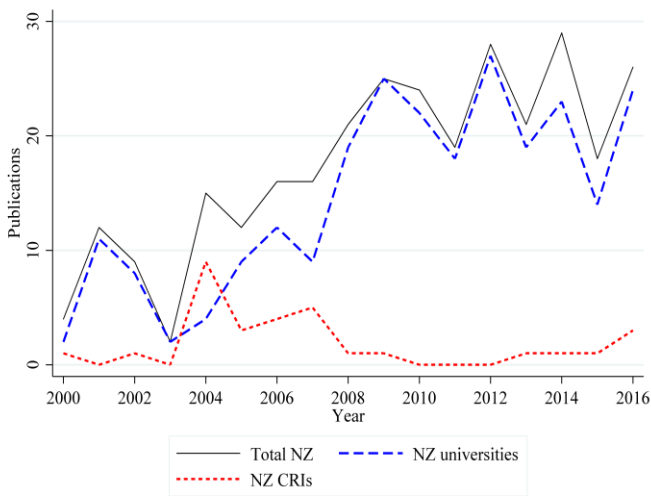
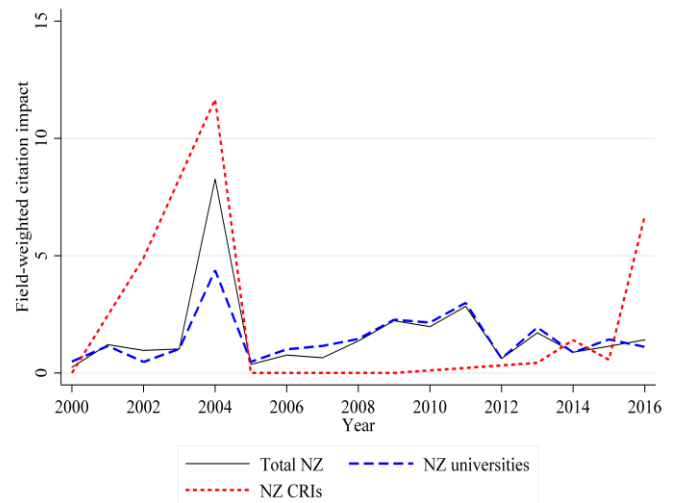


Figure 5: Engineering research output by narrow subject area

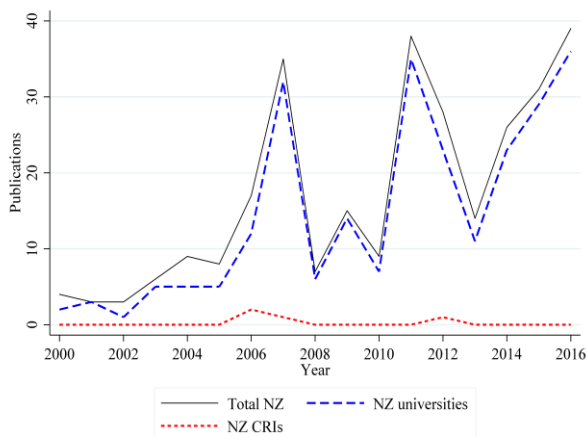
Panel A1: Aerospace eng pubs



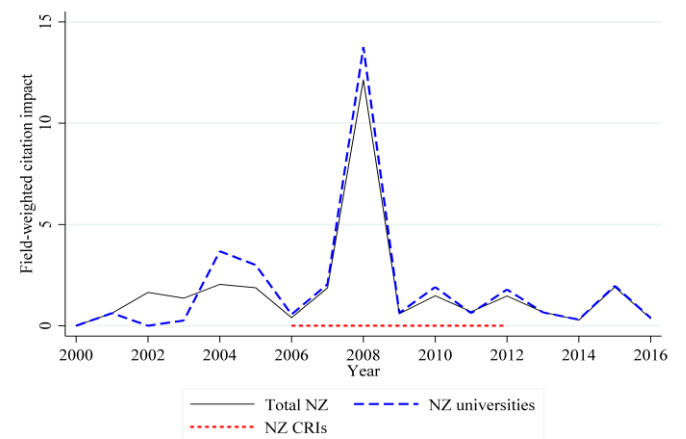
Panel A2: Aerospace eng citation impact



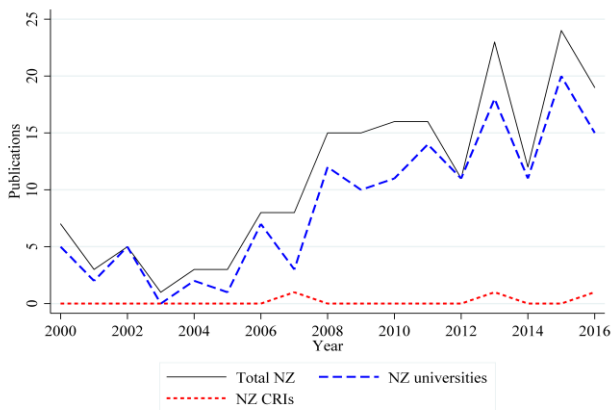
Panel B1: Architecture pubs



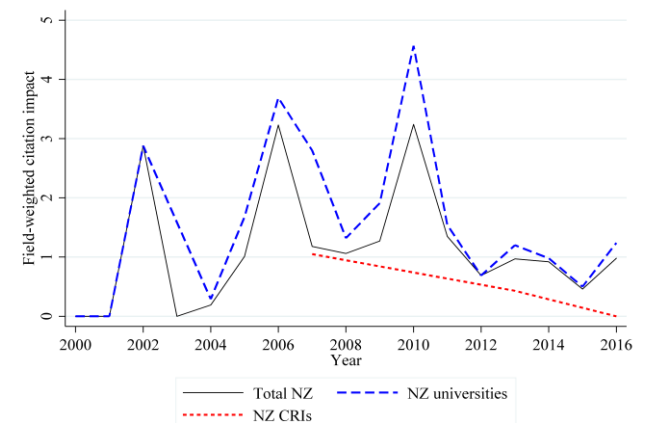
Panel B2: Architecture citation impact



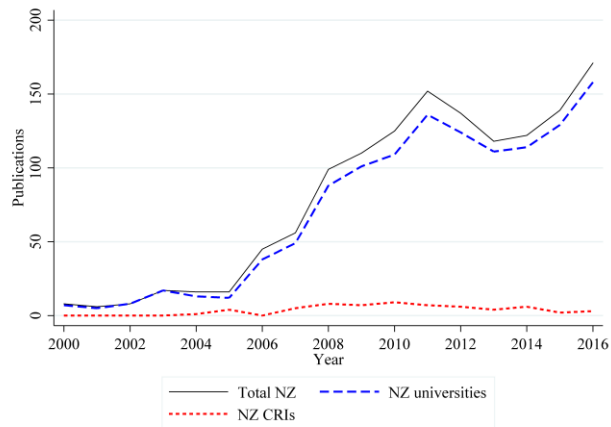
Panel C1: Automotive eng pubs



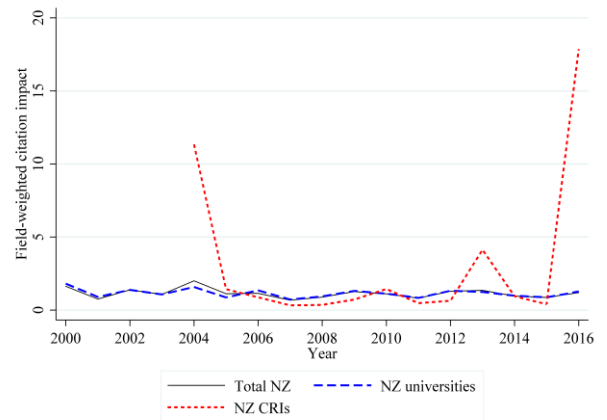
Panel C2: Automotive eng citation impact



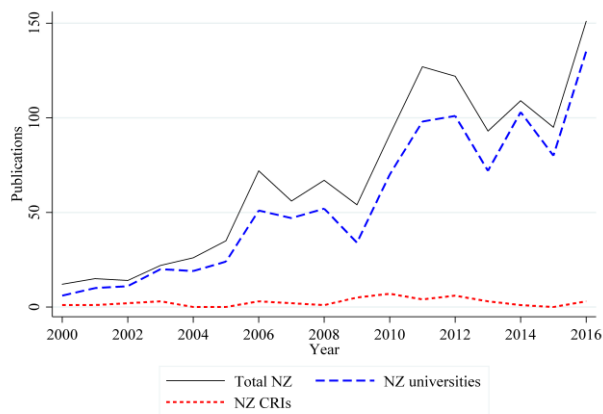
Panel D1: Biomed eng pubs



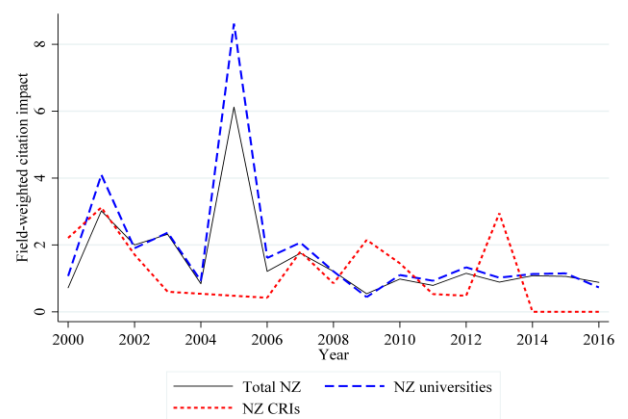
Panel D2: Biomed eng citation impact



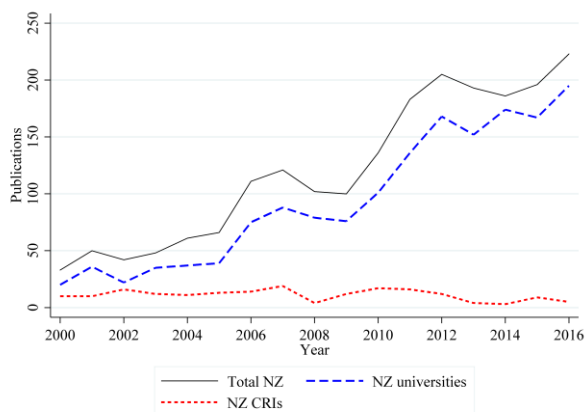
Panel E1: Building & constr pubs



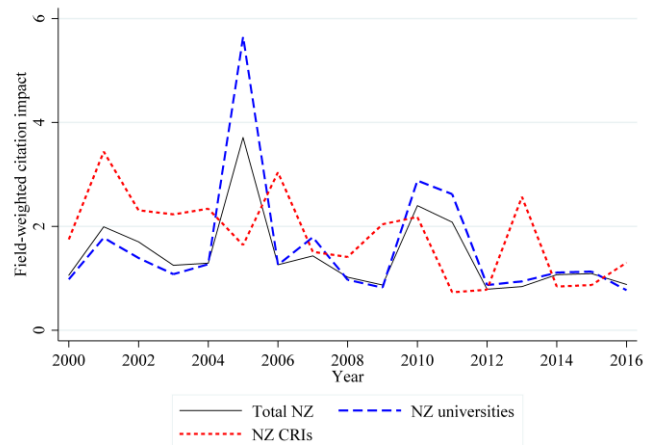
Panel E2: Building & constr citation impact



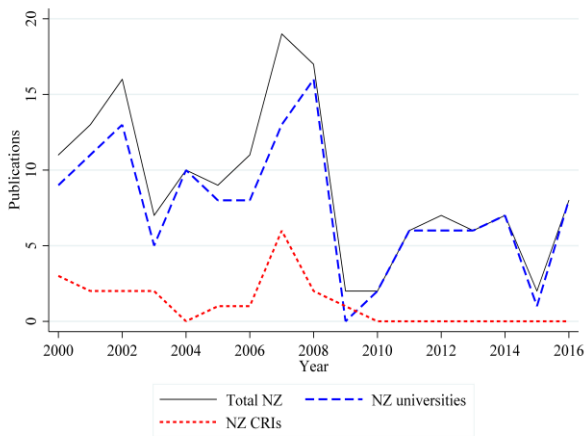
Panel F1: Civil eng pubs



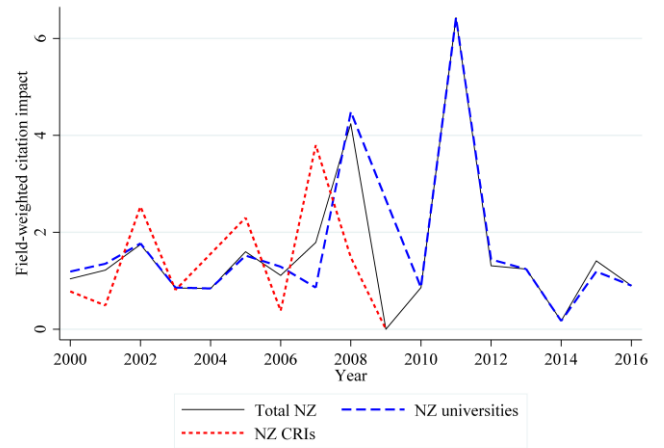
Panel F2: Civil eng citation impact



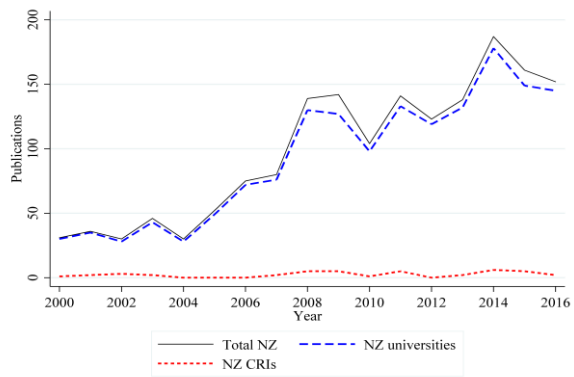
Panel G1: Computational mech pubs



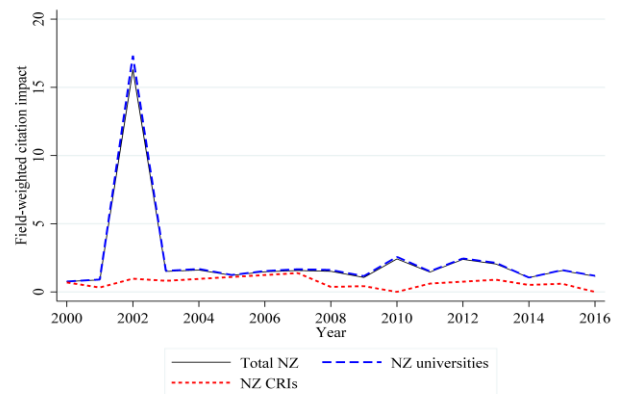
Panel G2: Computational mech citation impact



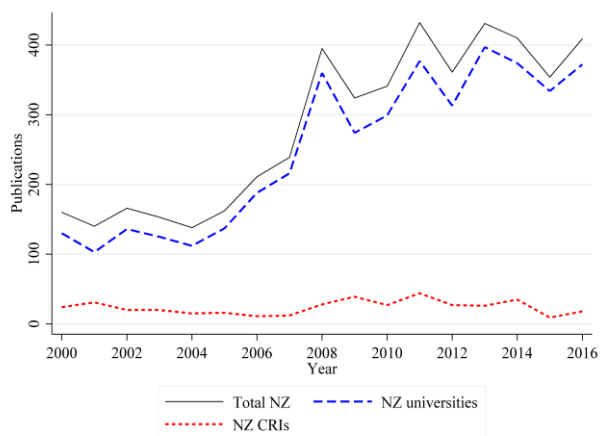
Panel H1: Control & systems pubs



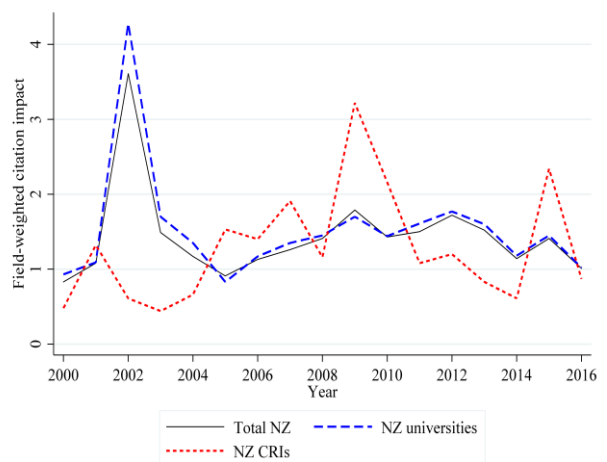
Panel H2: Control & systems citation impact



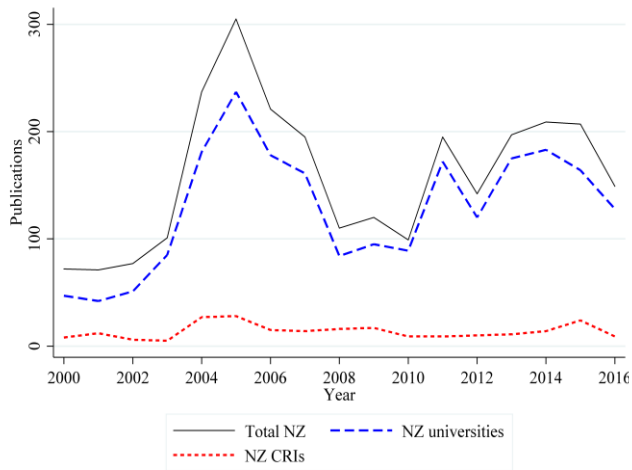
Panel I1: Electrical eng pubs



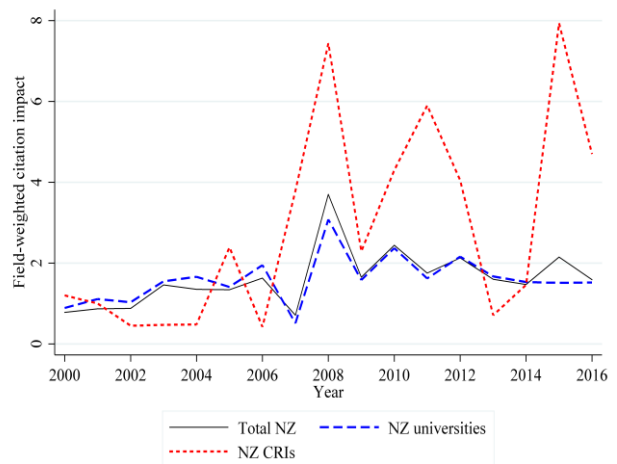
Panel I2: Electrical eng



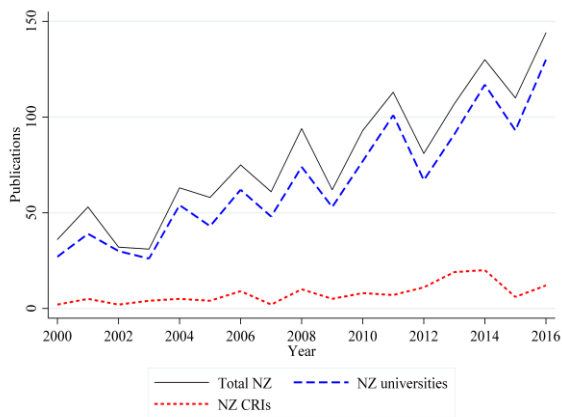
Panel J1: General engineering pubs



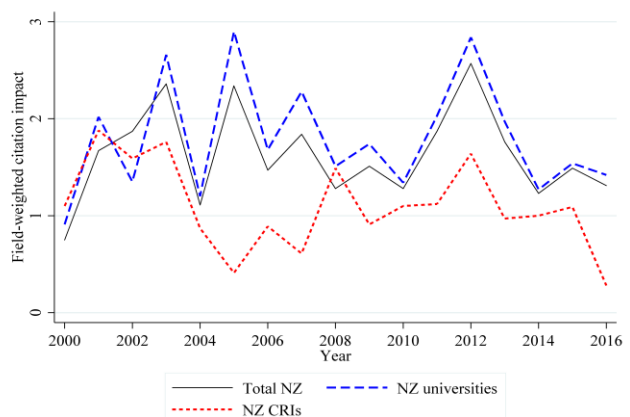
Panel J2: General engineering citation impact



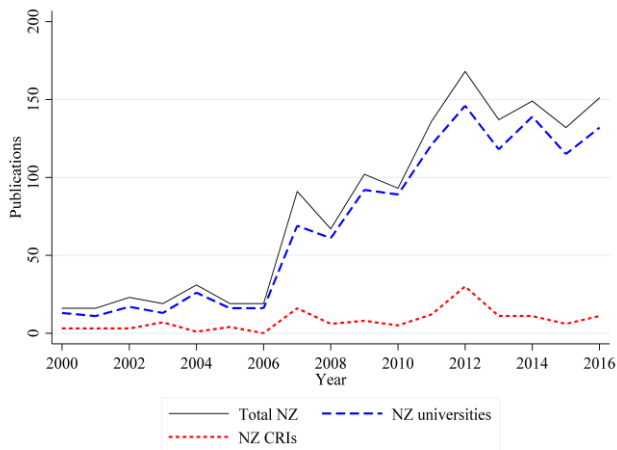
Panel K1: Industrial & manuf eng pubs



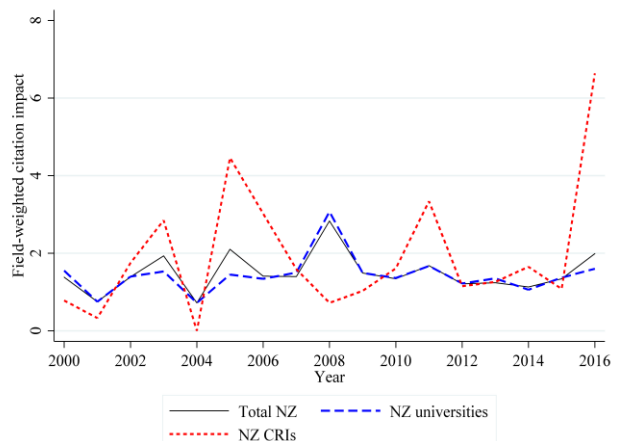
Panel K2: Industrial & manuf eng citation impact



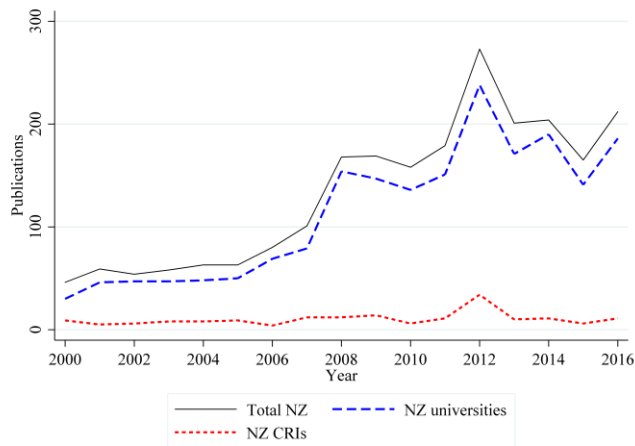
Panel L1: Material mechanics pubs



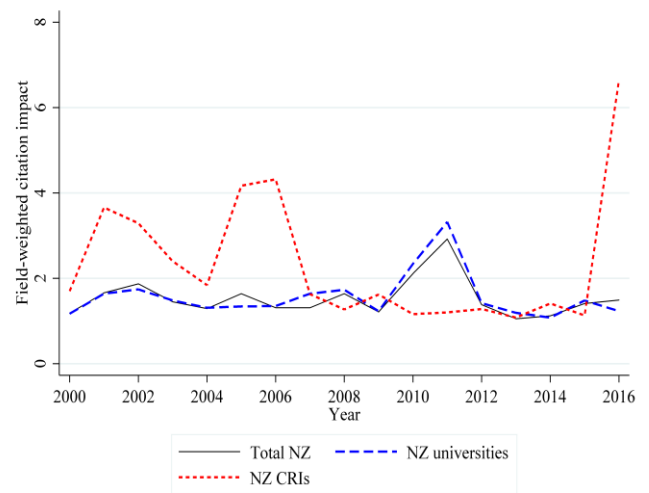
Panel L2: Material mechanics citation impact



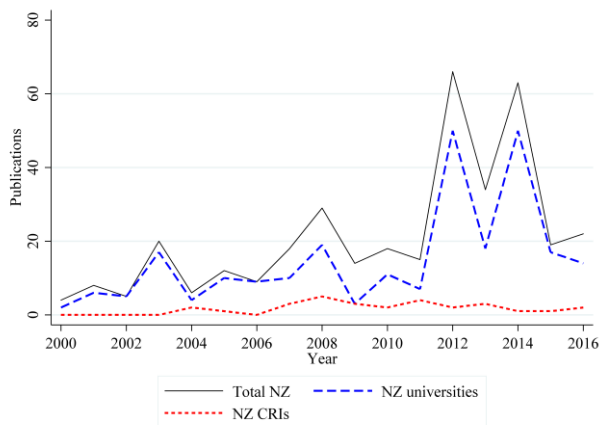
Panel M1: Mechanical eng pubs



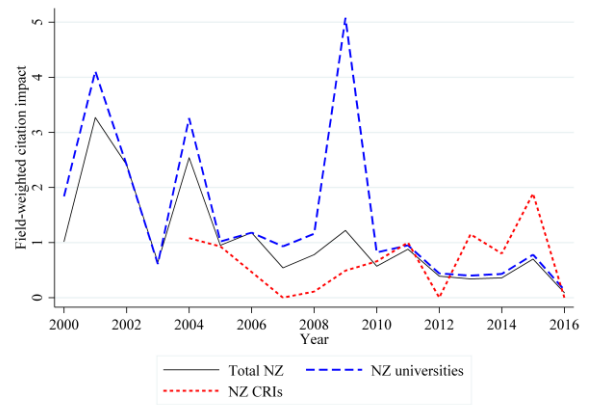
Panel M2: Mechanical eng citation impact



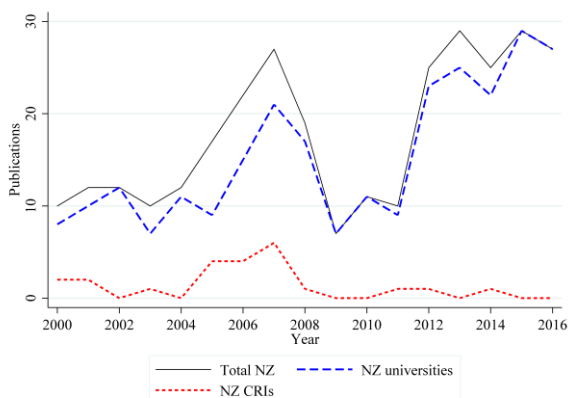
Panel N1: Media tech pubs



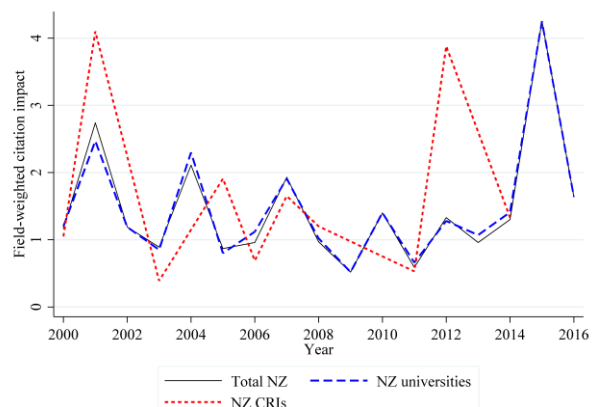
Panel N2: Media tech citation impact



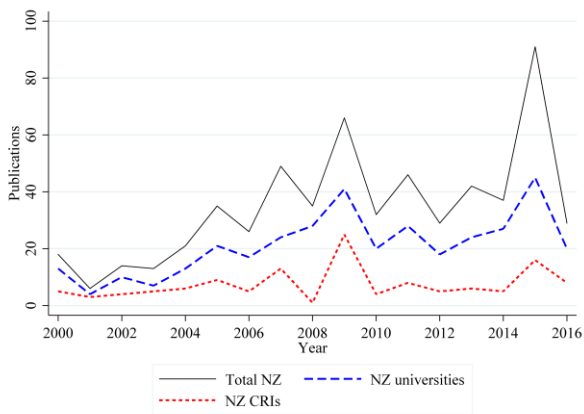
Panel O1: Misc. engineering pubs



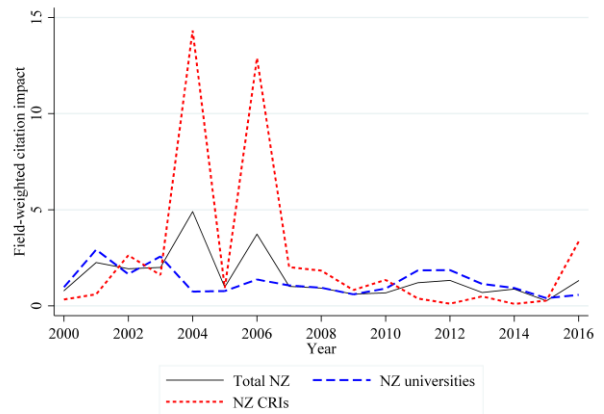
Panel O2: Misc. engineering citation impact



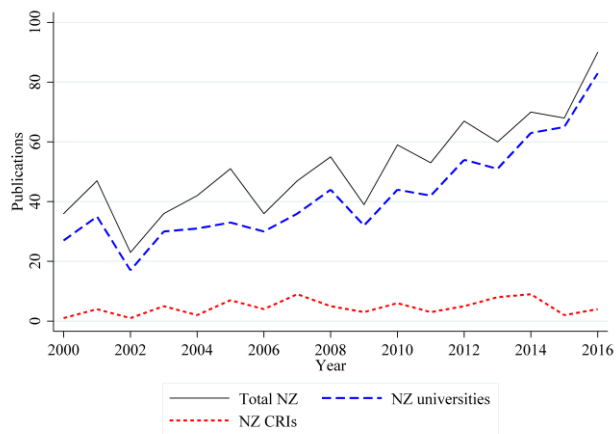
Panel O1: Ocean eng pubs



Panel O2: Ocean eng citation impact



Panel P1: Safety & risk pubs



Panel P2: Safety & risk citation impact

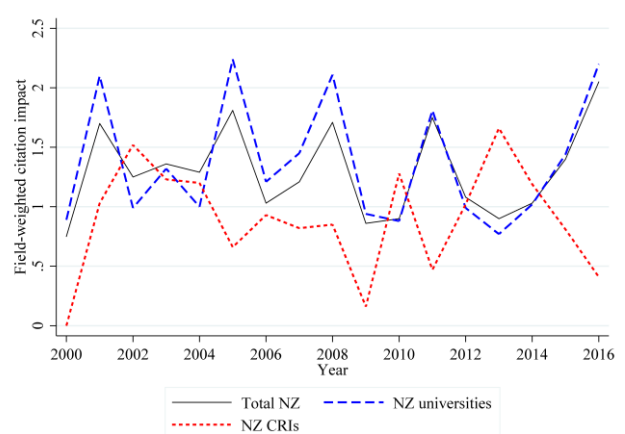
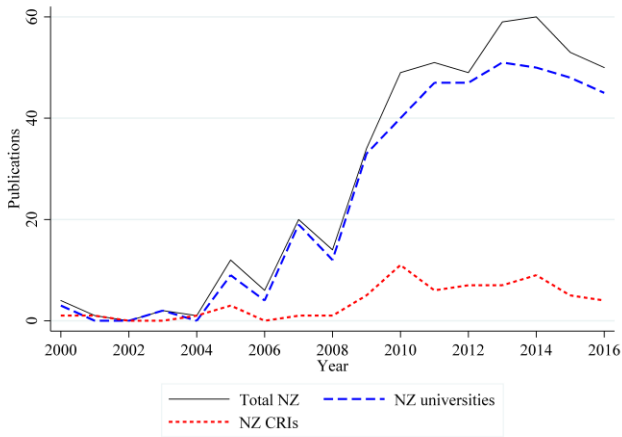
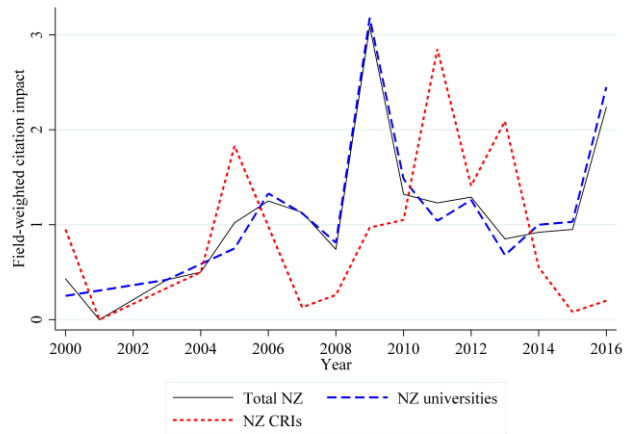


Figure 6: Materials science research output by narrow subject area

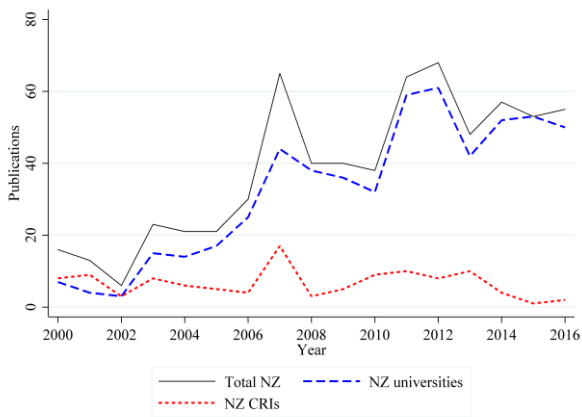
Panel A1: Biomaterials pubs



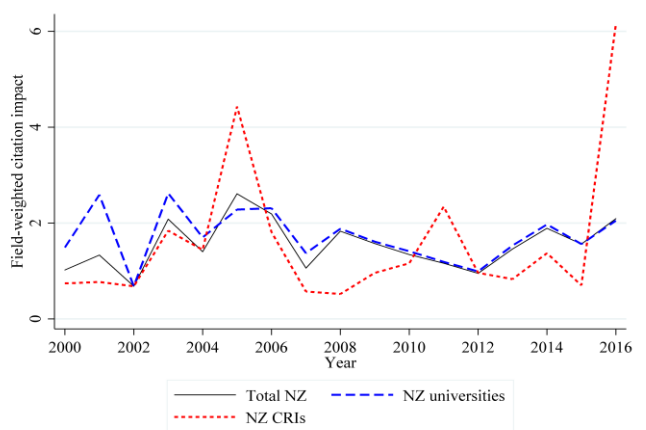
Panel A2: Biomaterials citation impact



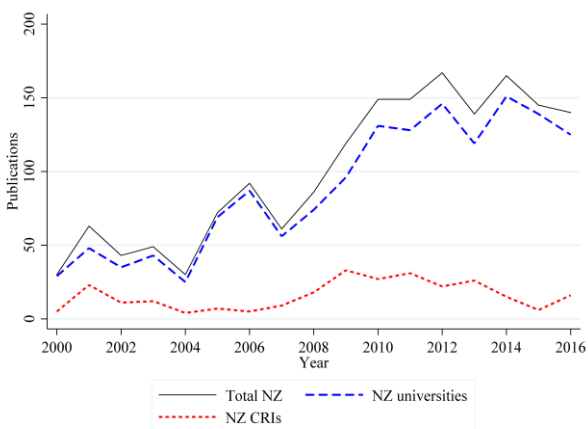
Panel B1: Ceramics pubs



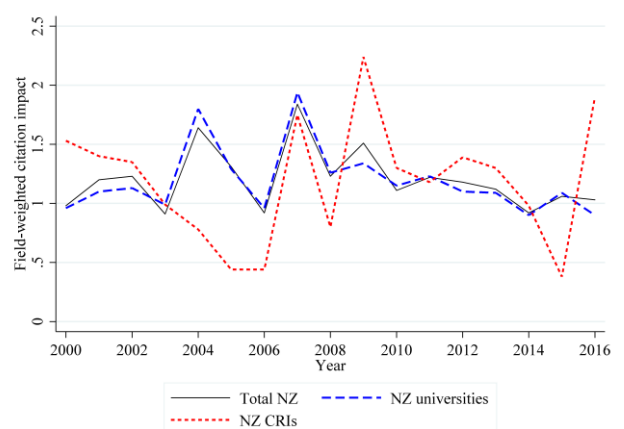
Panel B2: Ceramics citation impact



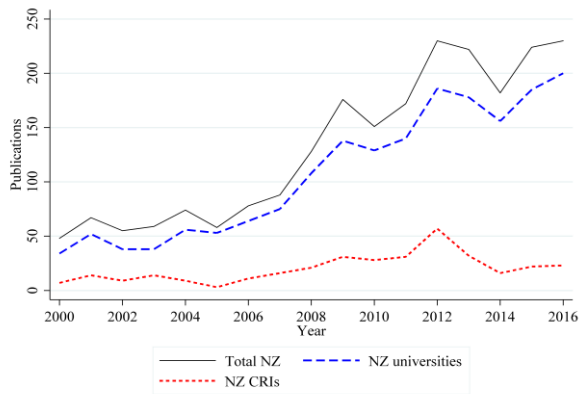
Panel C1: Electronic & optical pubs



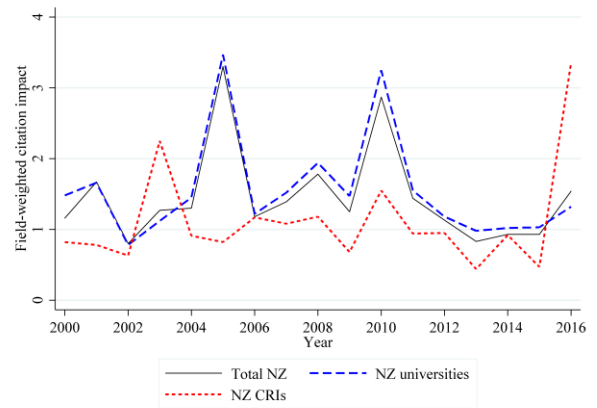
Panel C2: Electronic & optical citation impact



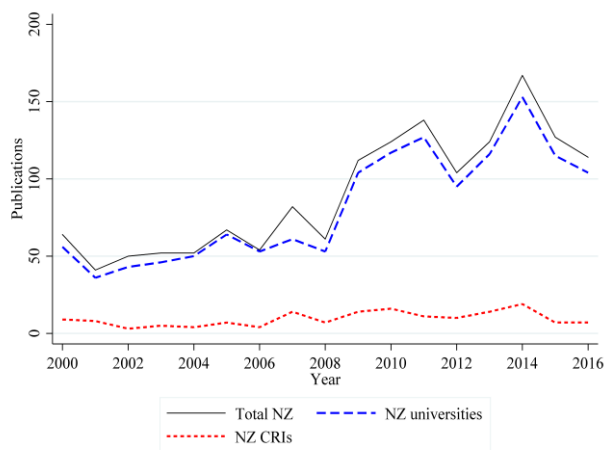
Panel D1: General materials pubs



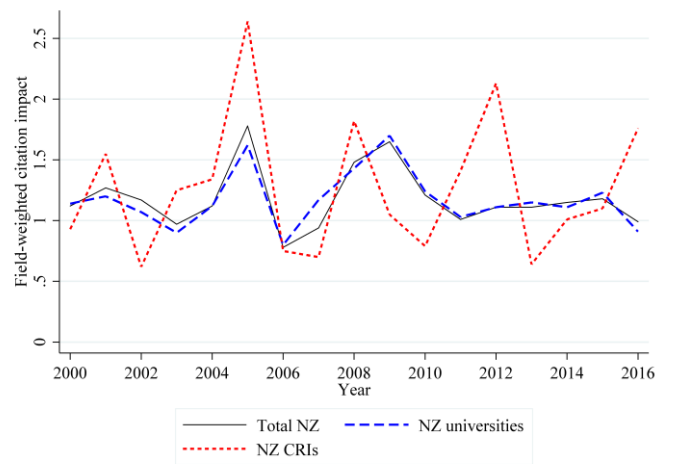
Panel D2: General materials citation impact



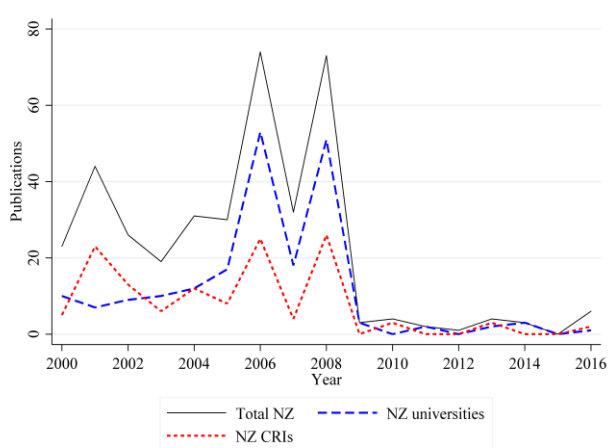
Panel E1: Materials chem pubs



Panel E2: Materials chem citation impact



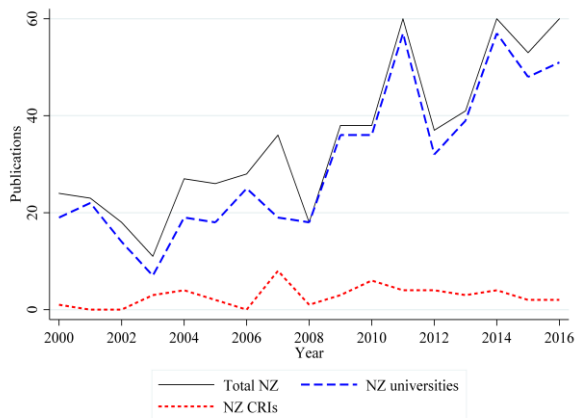
Panel F1: Misc. materials pubs



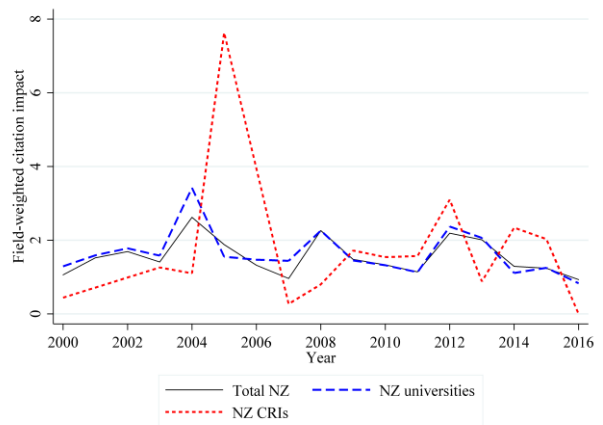
Panel F2: Misc. materials citation impact



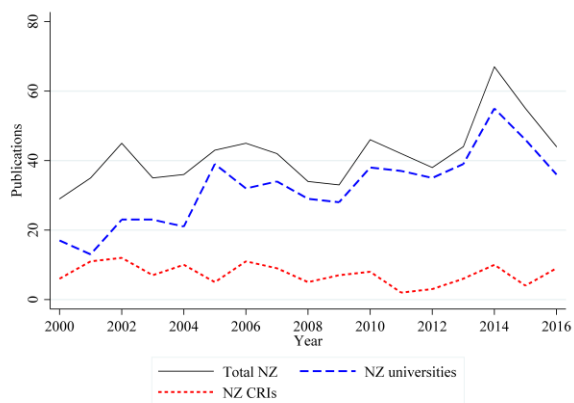
Panel G1: Metals & alloys pubs



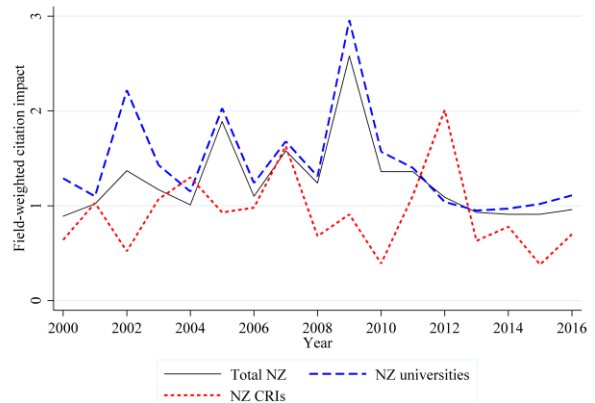
Panel G2: Metals & alloys citation impact



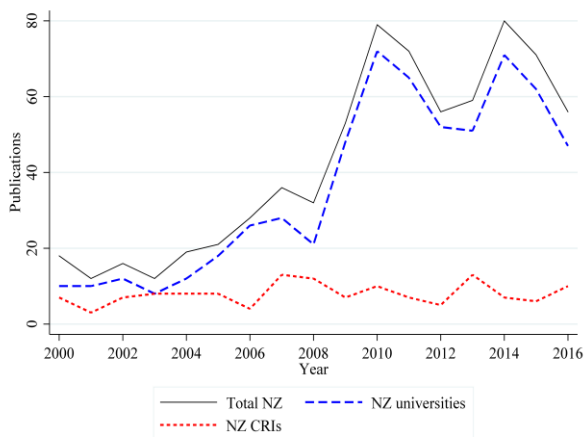
Panel H1: Polymers & plastics pubs



Panel H2: Polymers & plastics citation impact



Panel I1: Surfaces & coatings pubs



Panel I2: Surfaces & coatings citation impact

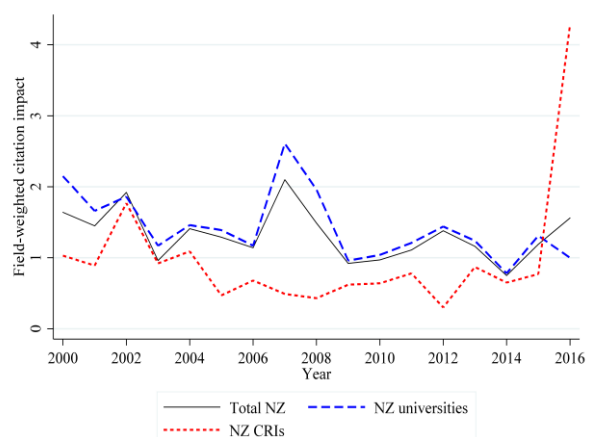
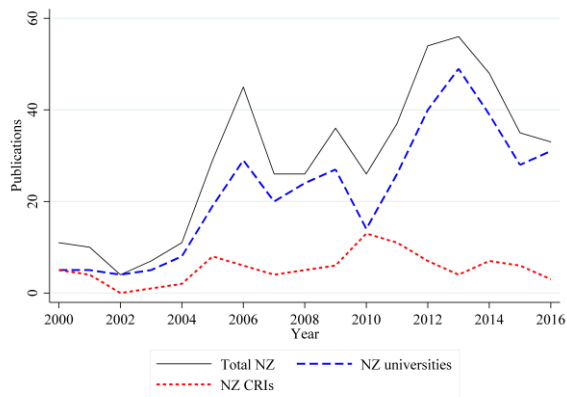
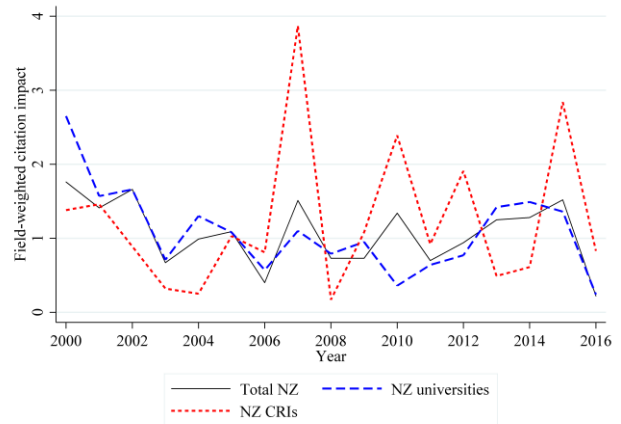


Figure 7: Physics & astronomy research output by narrow subject area

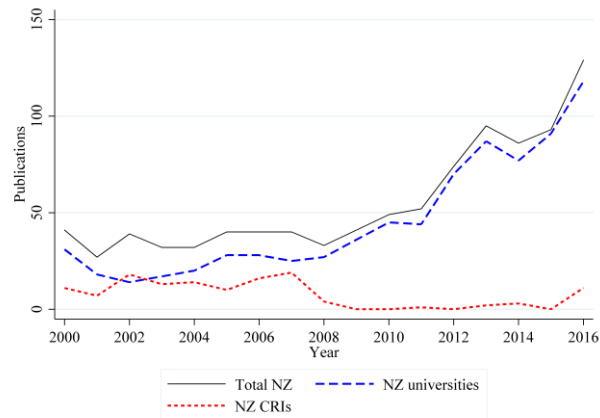
Panel A1: Acoustics pubs



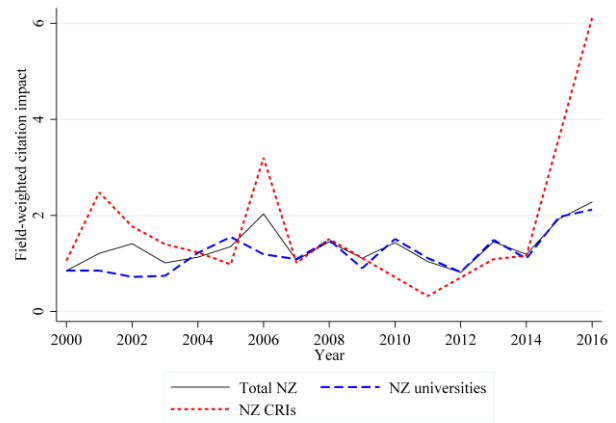
Panel A2: Acoustics citation impact



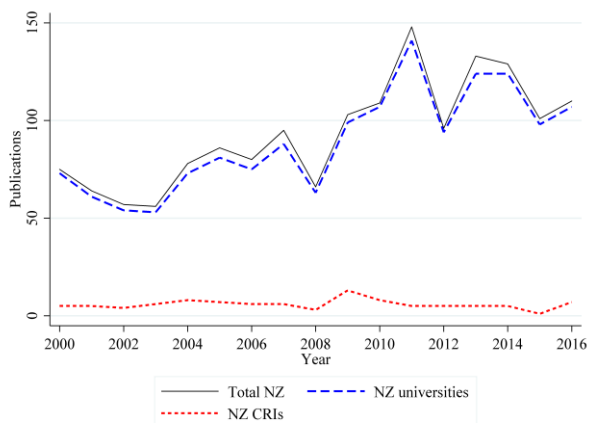
Panel B1: Astronomy pubs



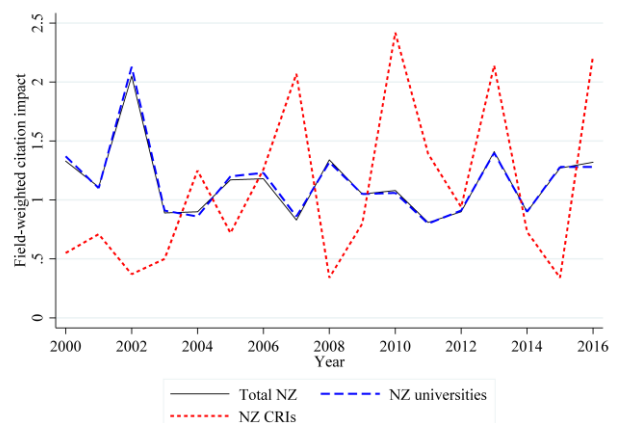
Panel B2: Astronomy citation impact



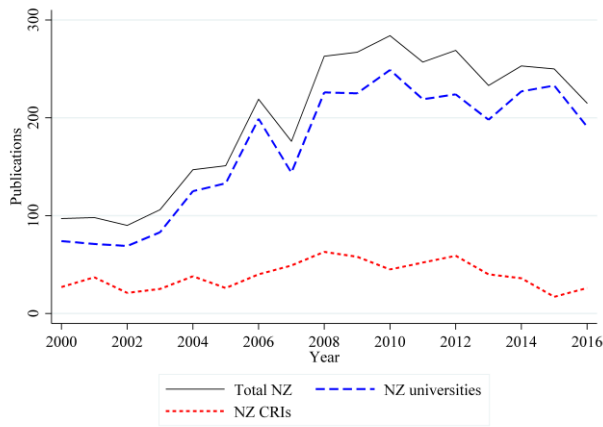
Panel C1: Atomic & molecular pubs



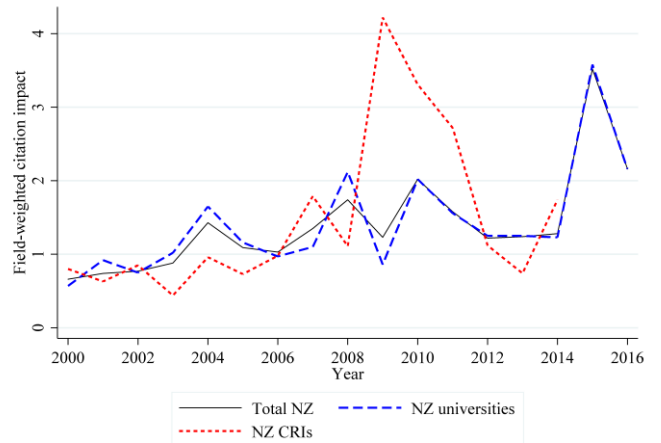
Panel C2: Atomic & molecular citation impact



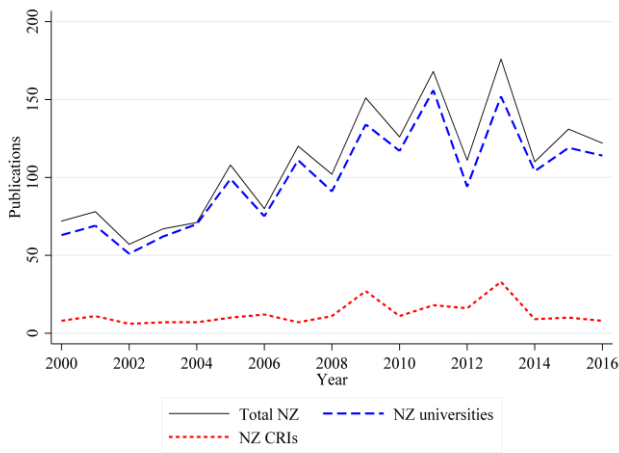
Panel D1: Condensed matter pubs



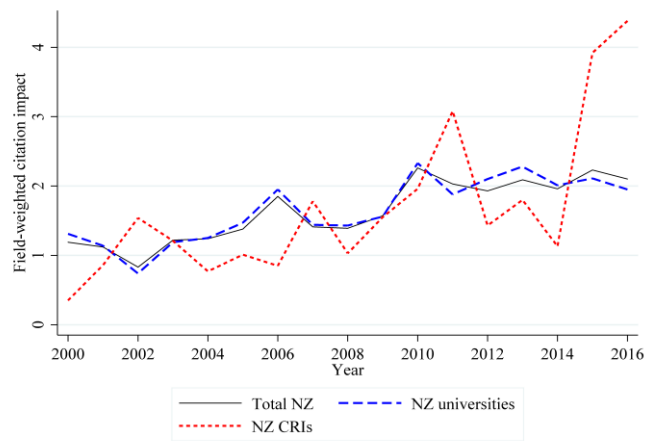
Panel D2: Condensed matter citation impact



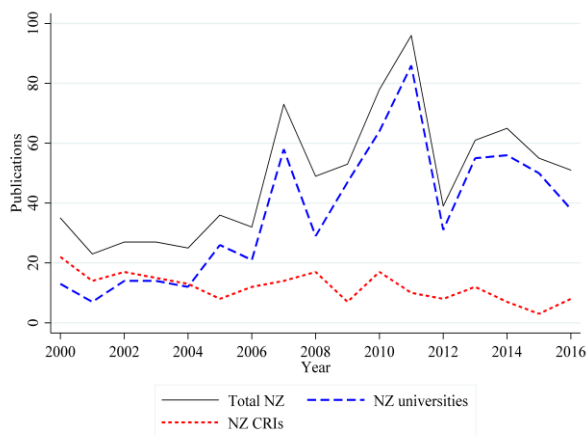
Panel E1: General physics pubs



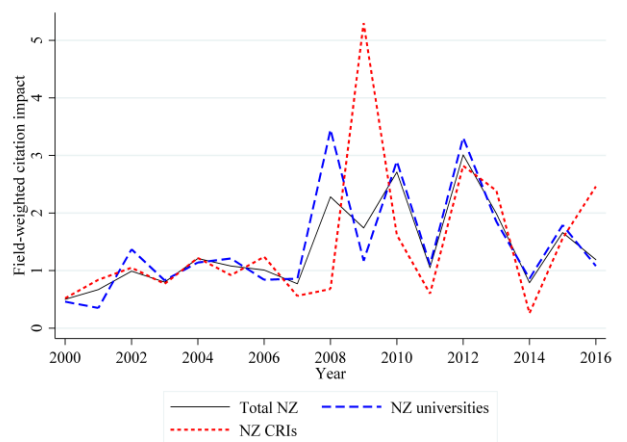
Panel E2: General physics citation impact



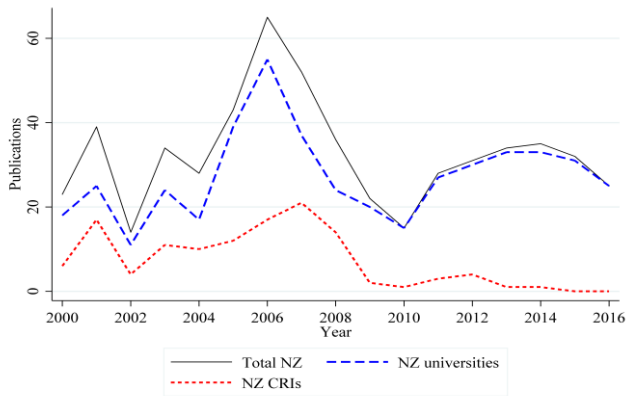
Panel F1: Instrumentation pubs



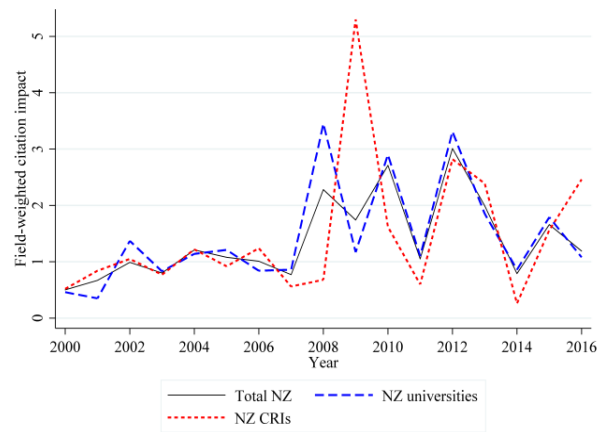
Panel F2: Instrumentation citation impact



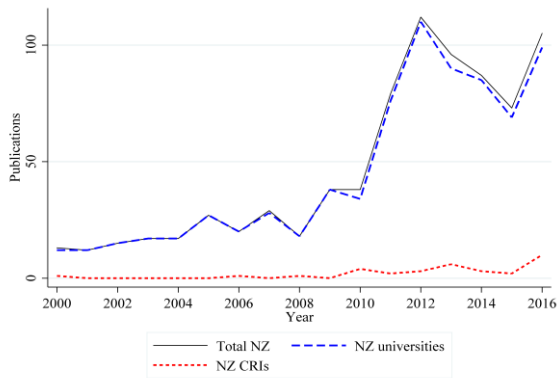
Panel G1: Misc. physics pubs



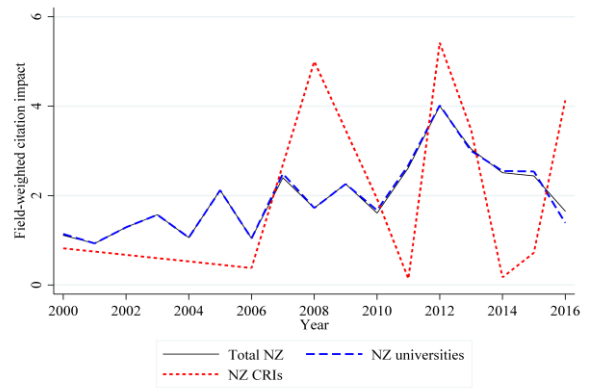
Panel G2: Misc. physics citation impact



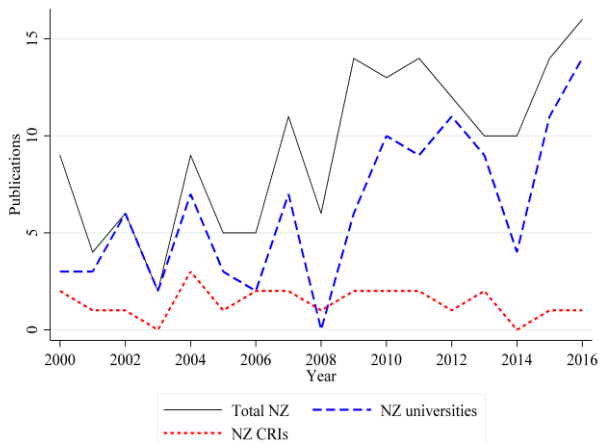
Panel H1: Nuclear physics pubs



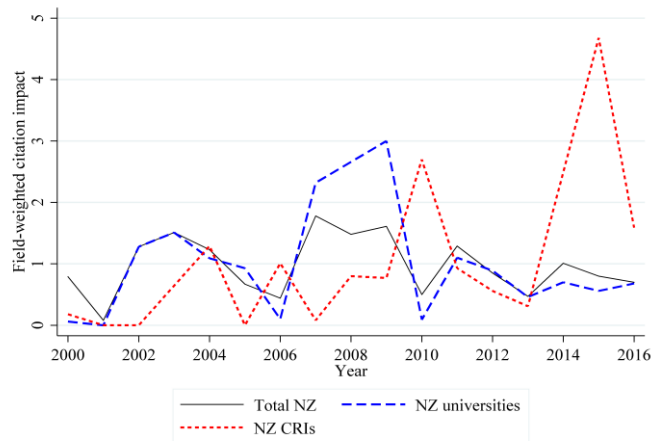
Panel H2: Nuclear physics citation impact



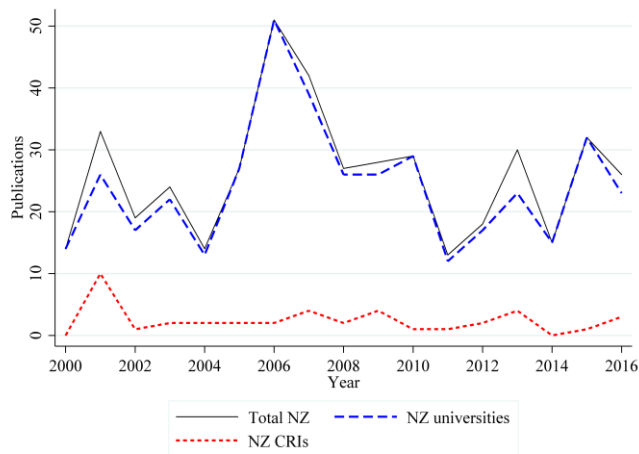
Panel I1: Radiation pubs



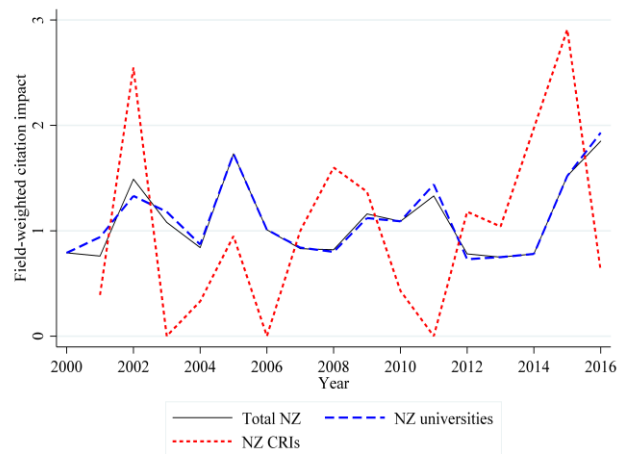
Panel I2: Radiation citation impact



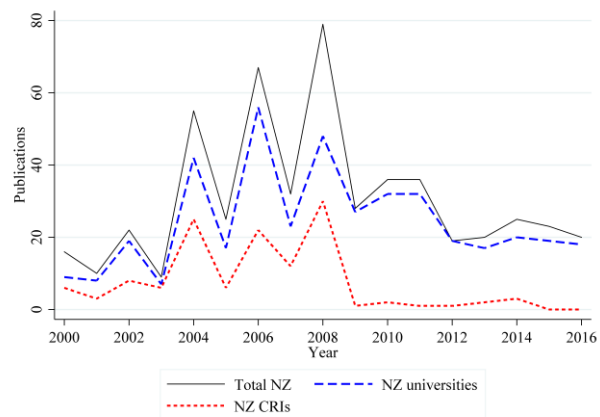
Panel J1: Statistical physics pubs



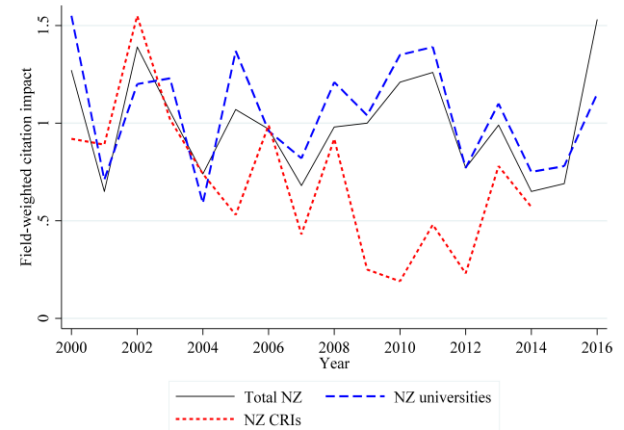
Panel J2: Statistical physics citation impact



Panel K1: Surfaces/interfaces pubs



Panel K2: Surfaces/interfaces citation impact



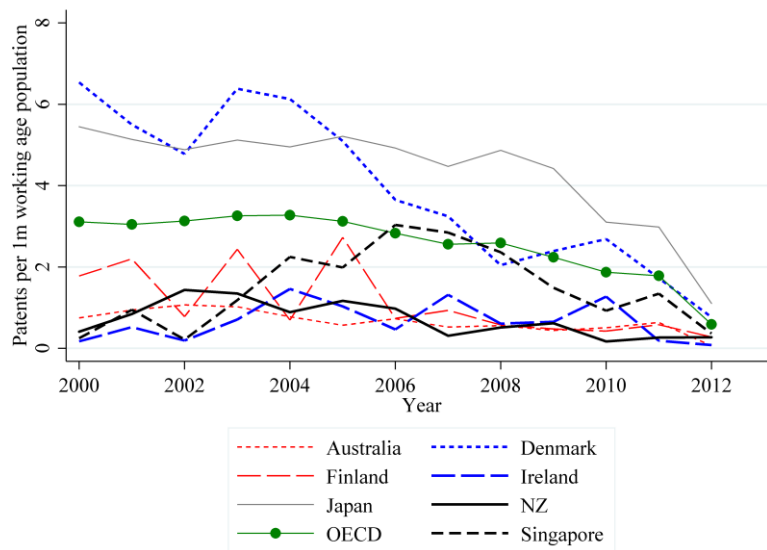
Notes: Data come from SciVal, which uses the Scopus database along with affiliation identifiers to group together the research output of different institutions. The number of publications includes all publication types (articles, reviews, conference papers, editorials and short surveys). The field-weighted citation is the ratio of citations received relative to the expected world average for the subject field, publication type (of which we include all) and publication year. The category 'Total NZ' includes any New Zealand author, regardless of whether they are affiliated with an NZ university or CRI.

III. Triadic patent applications, NZ and other countries

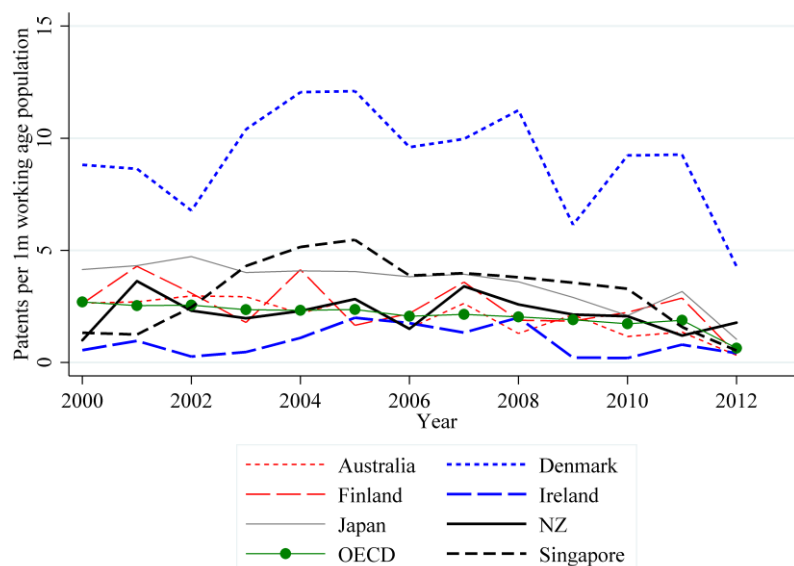
This section shows the number of patents of narrowly-defined technology type filed in Europe, Japan and the US (triadic patents). Numbers are expressed as a proportion of the working age population, for NZ and comparable countries.

Figure 8: Chemistry patents, NZ & other countries

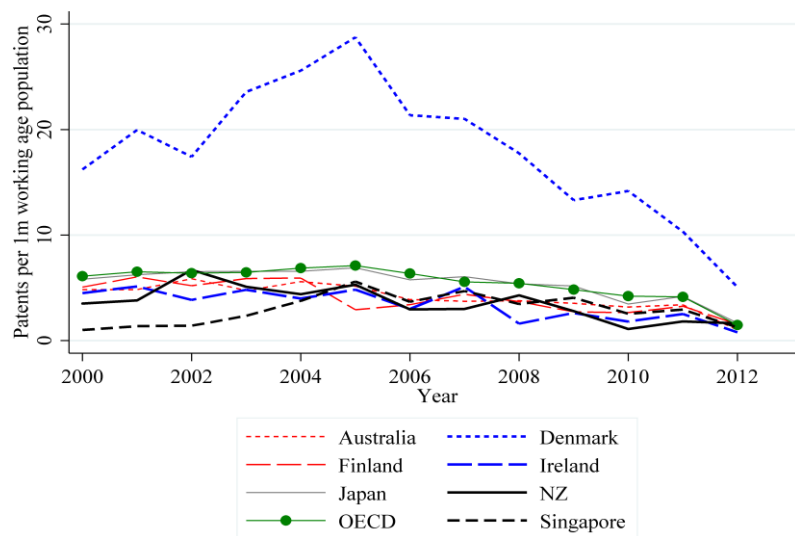
Panel A: Organic fine chemistry patents



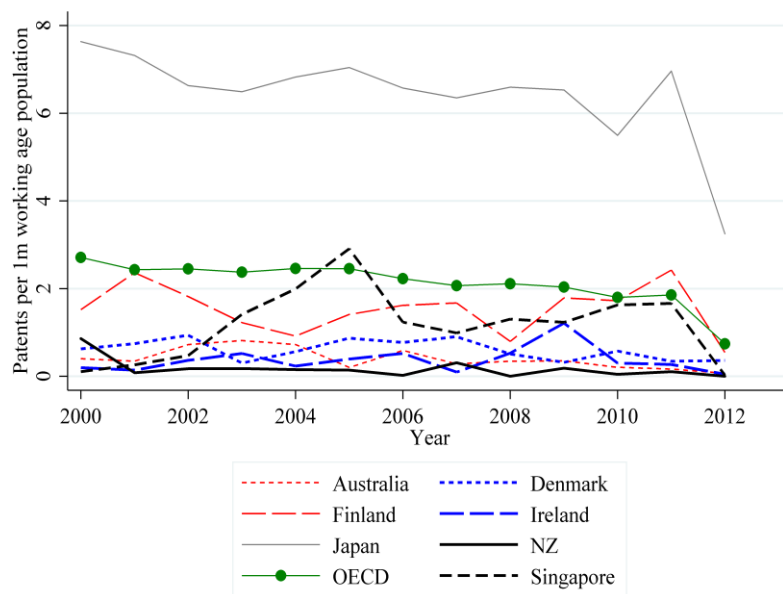
Panel B: Biotechnology patents



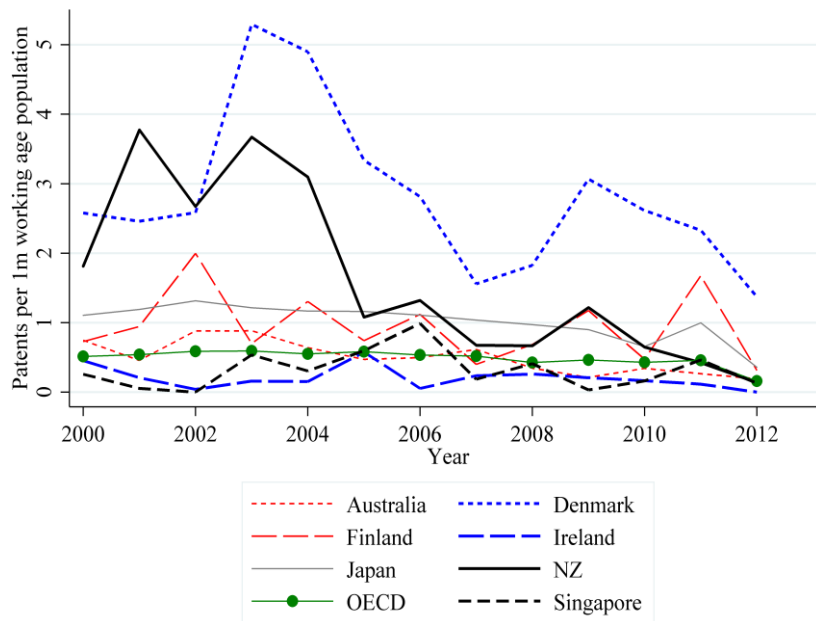
Panel C: Pharmaceuticals patents



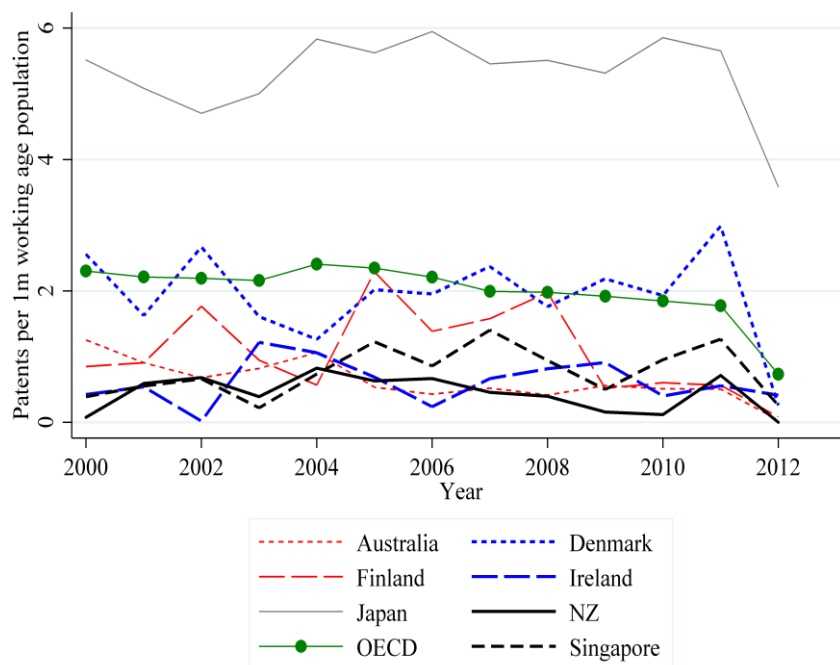
Panel D: Macromolecular chemistry & polymers patents



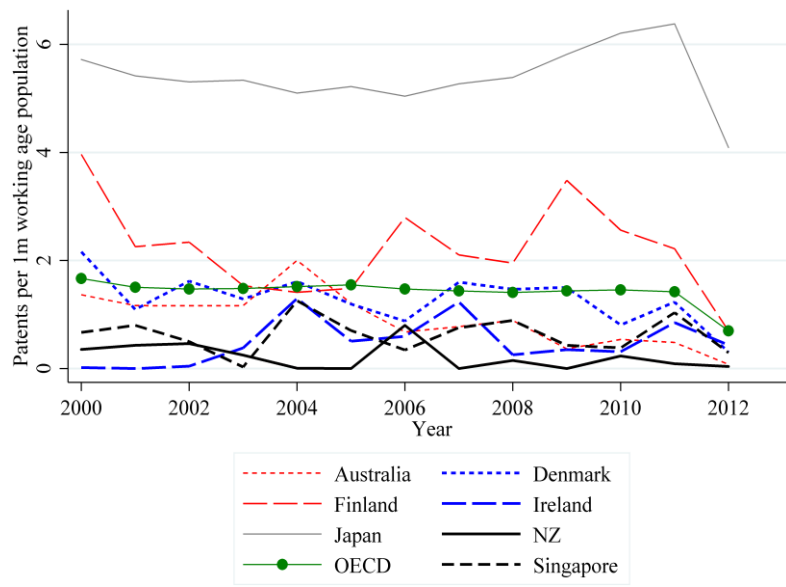
Panel E: Food chemistry patents



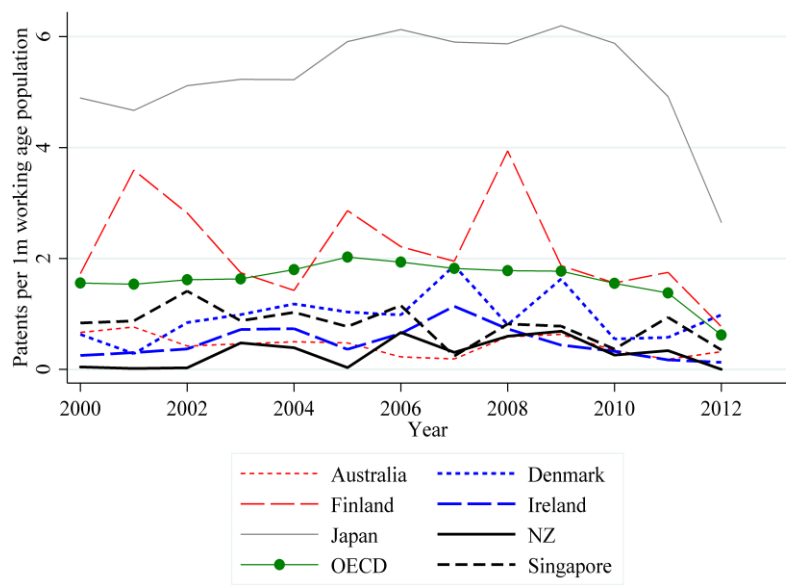
Panel F: Basic materials chemistry patents



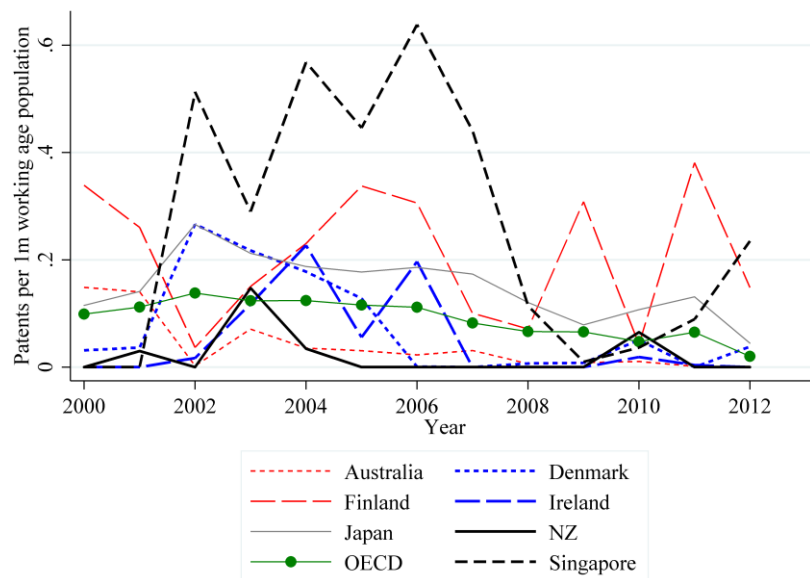
Panel G: Materials & metallurgy patents



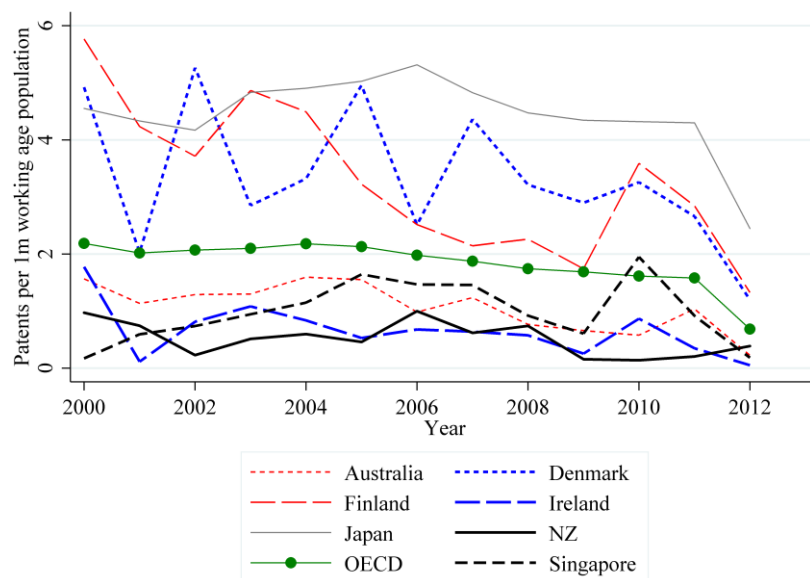
Panel H: Surface technology & coating patents



Panel I: Micro-structure & nano-technology patents



Panel J: Chemical engineering patents



Panel K: Environmental technology patents

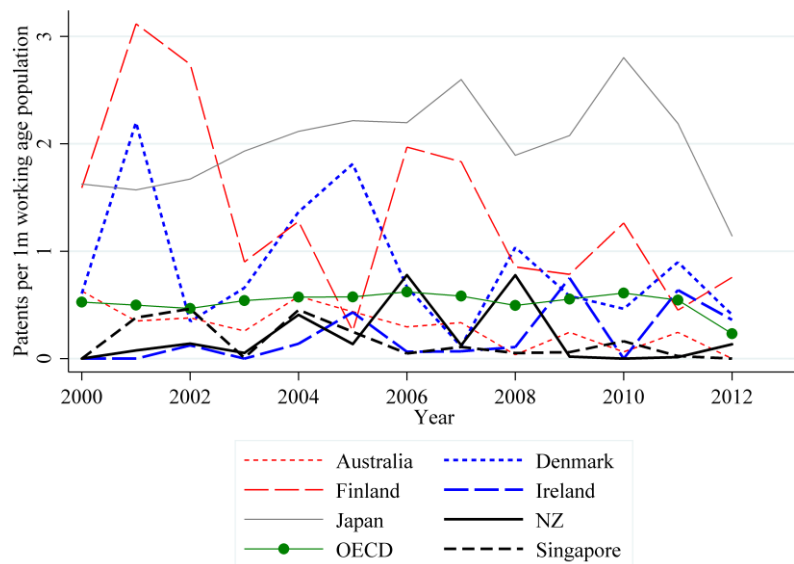
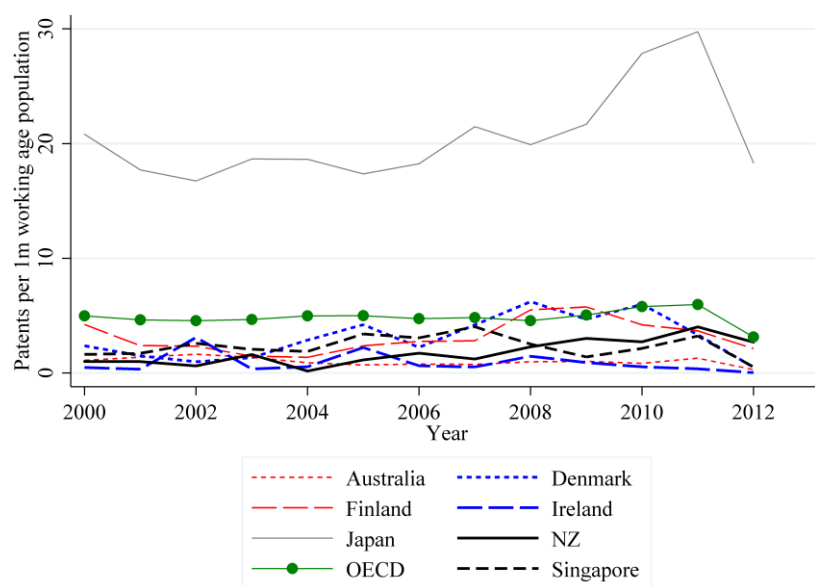
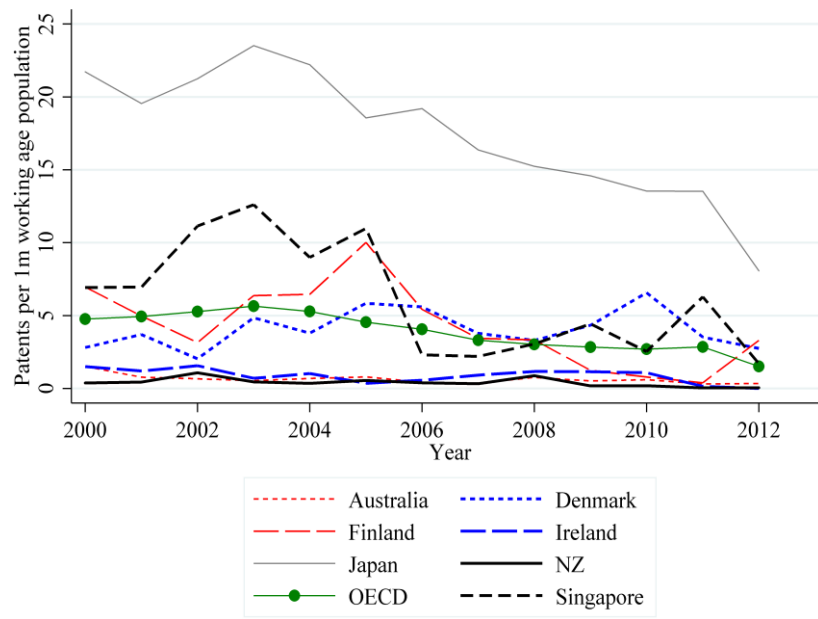


Figure 9: Electrical engineering patents, NZ & other countries

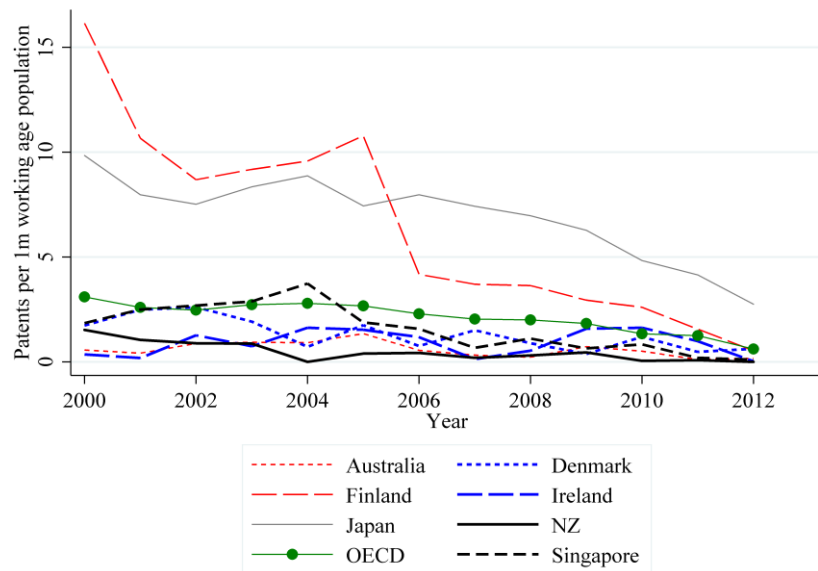
Panel A: Electrical machinery, apparatus, energy patents



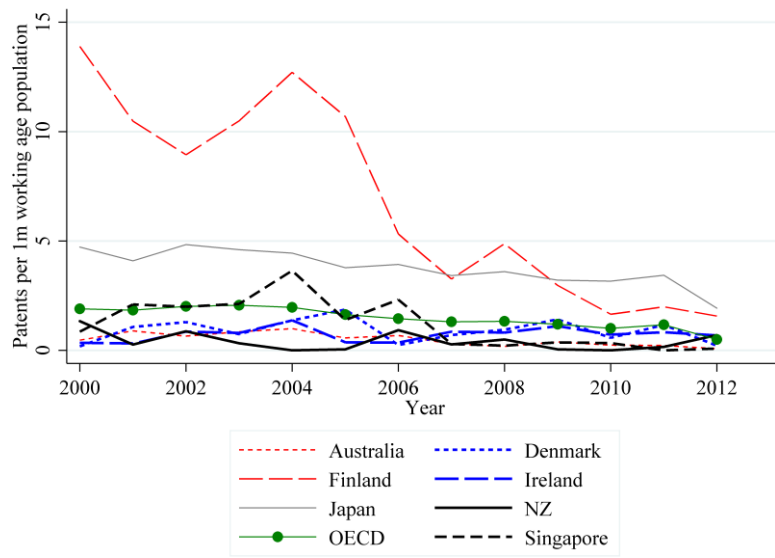
Panel B: Audio-visual technology patents



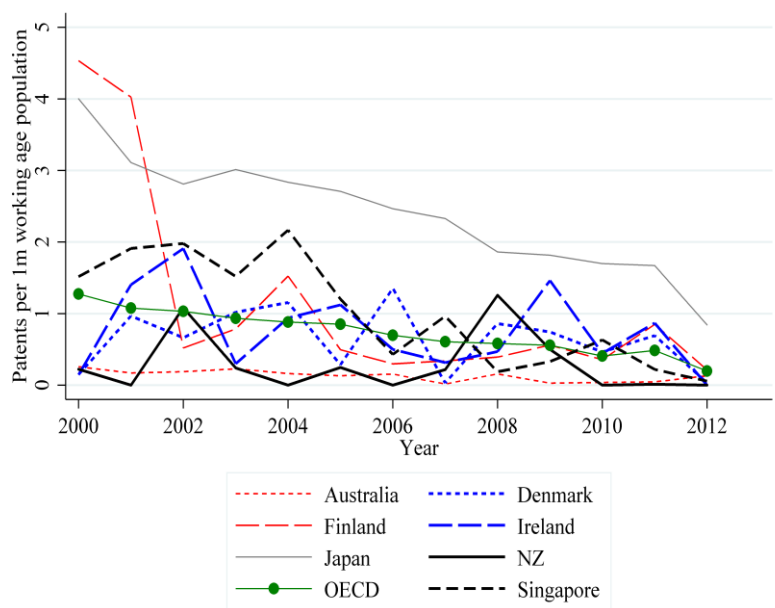
Panel C: Telecommunications patents



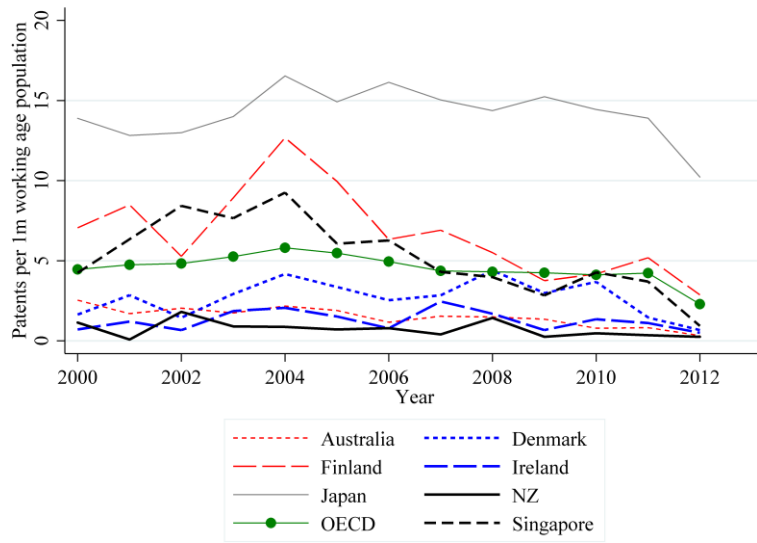
Panel D: Digital communication patents



Panel E: Basic communication processes patents



Panel F: Computer technology patents



Panel G: Semiconductors patents

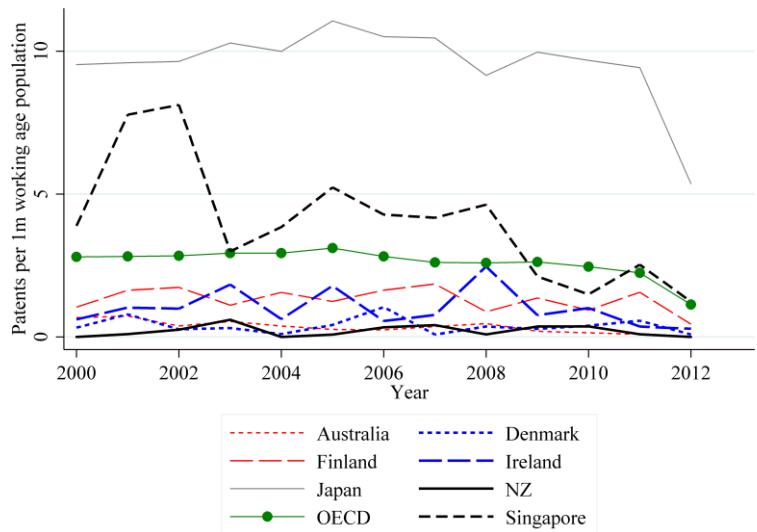
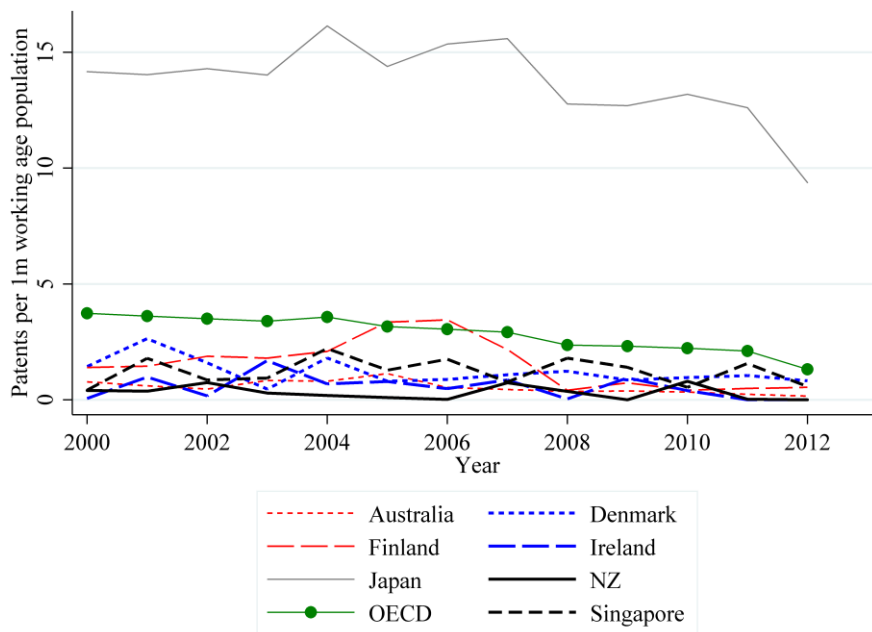
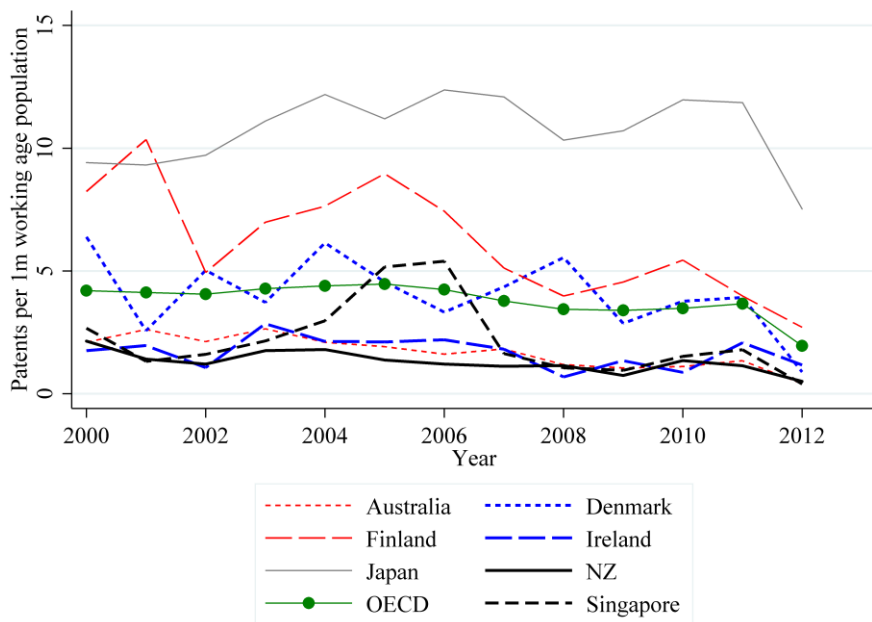


Figure 10: Instruments patents, NZ & other countries

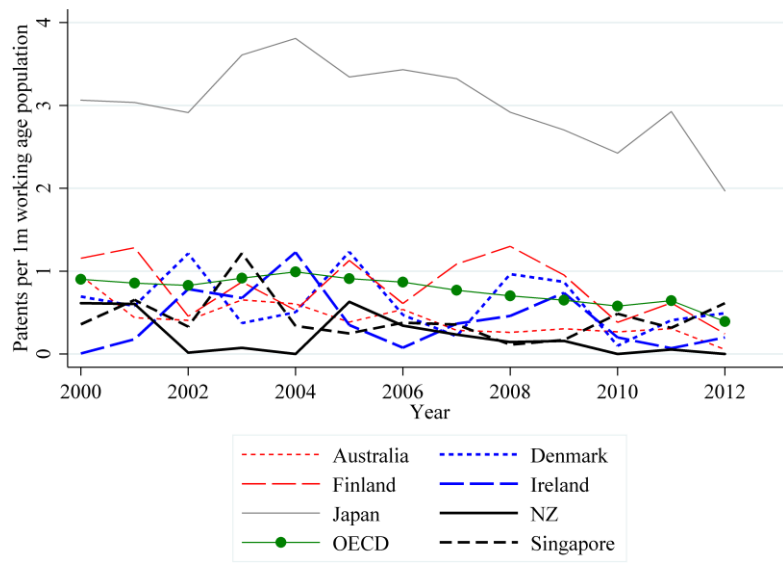
Panel A: Optics patents



Panel B: Measurement patents



Panel C: Control patents



Panel D: Medical technology patents

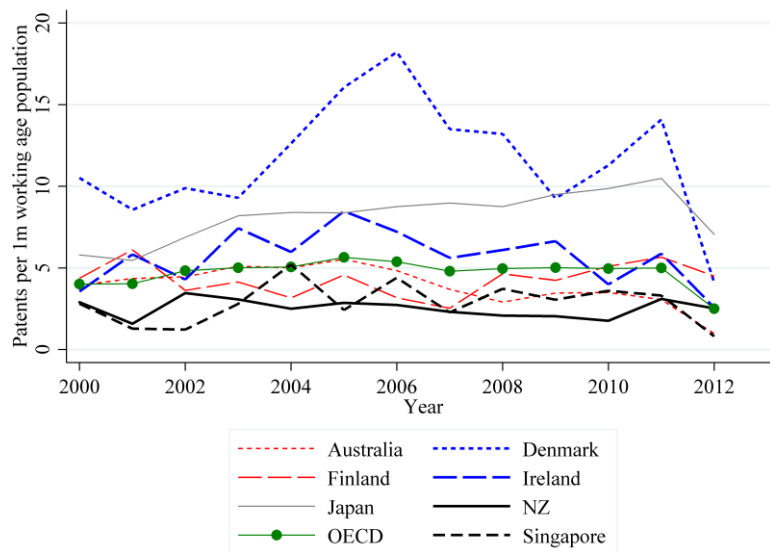
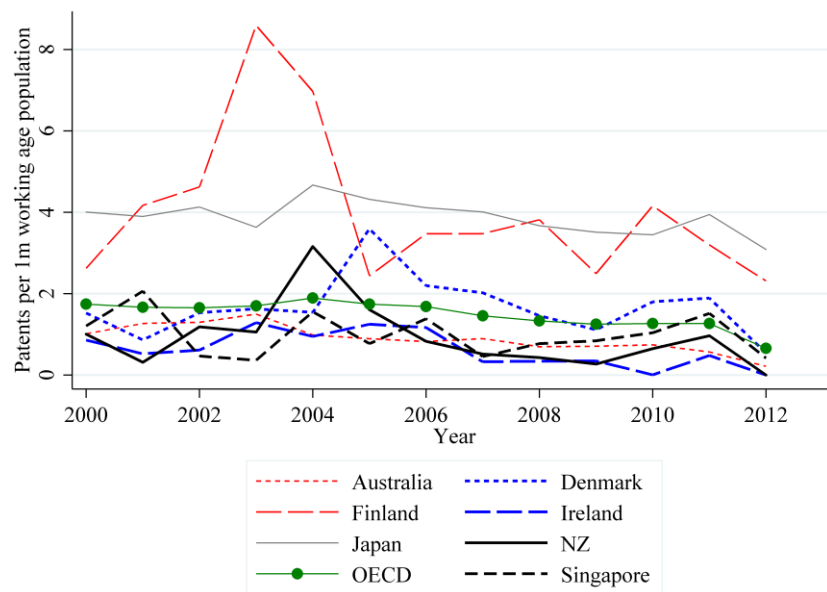
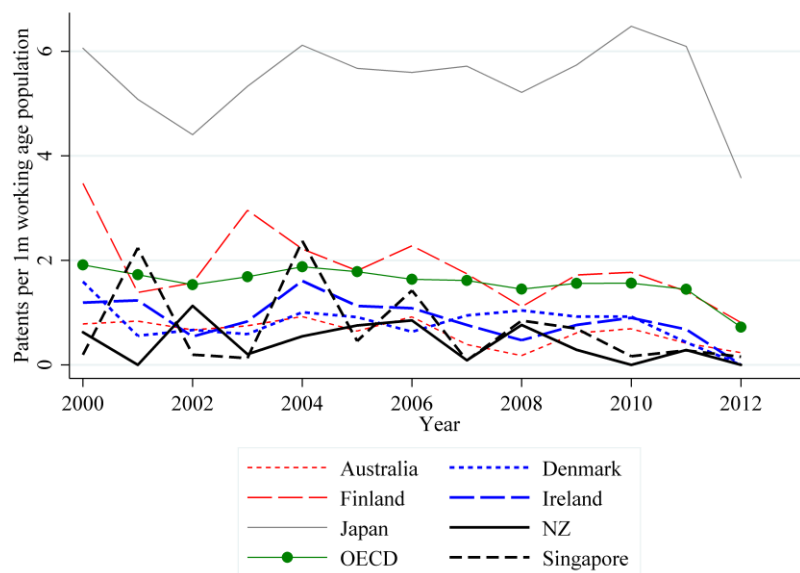


Figure 11: Mechanical engineering patents, NZ & other countries

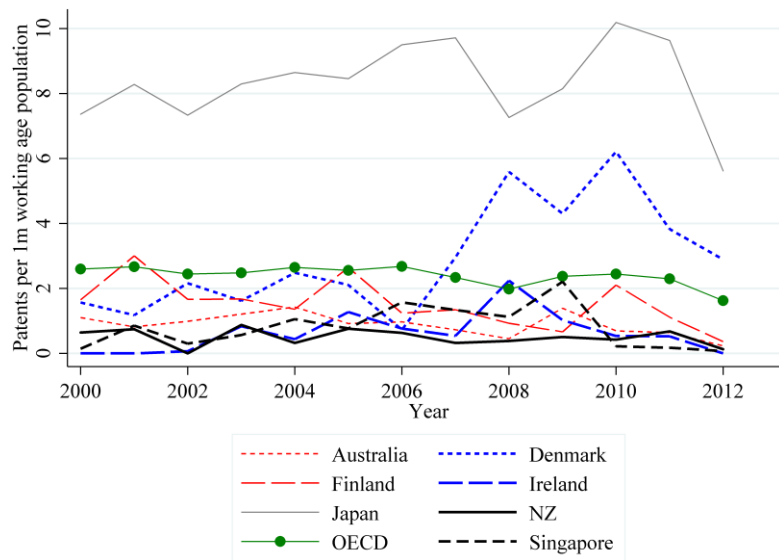
Panel A: Handling patents



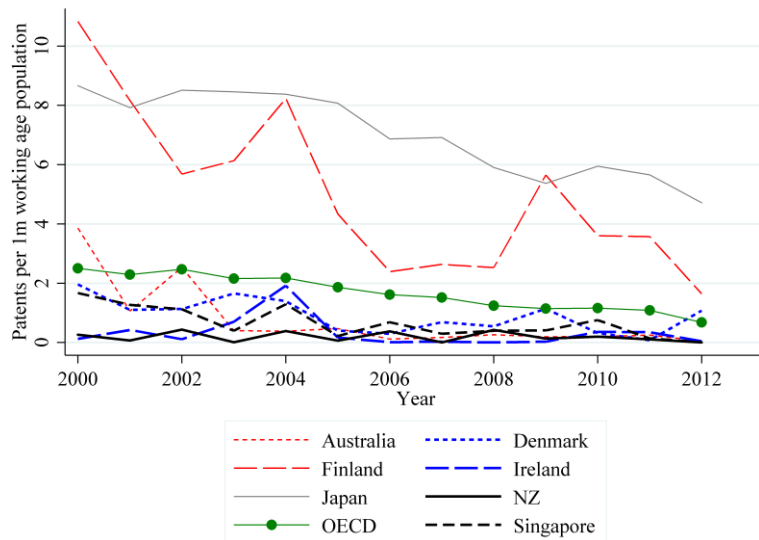
Panel B: Machine tools patents



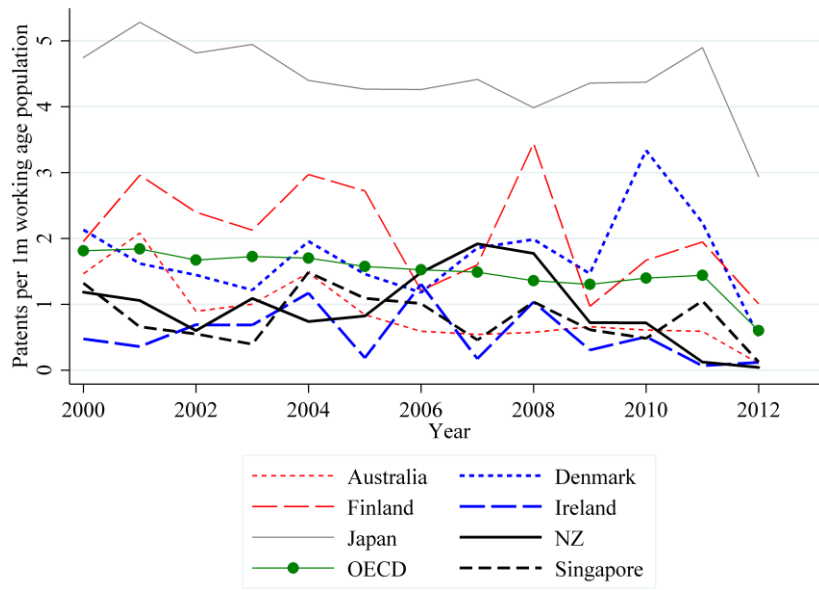
Panel C: Engines, pumps & turbines patents



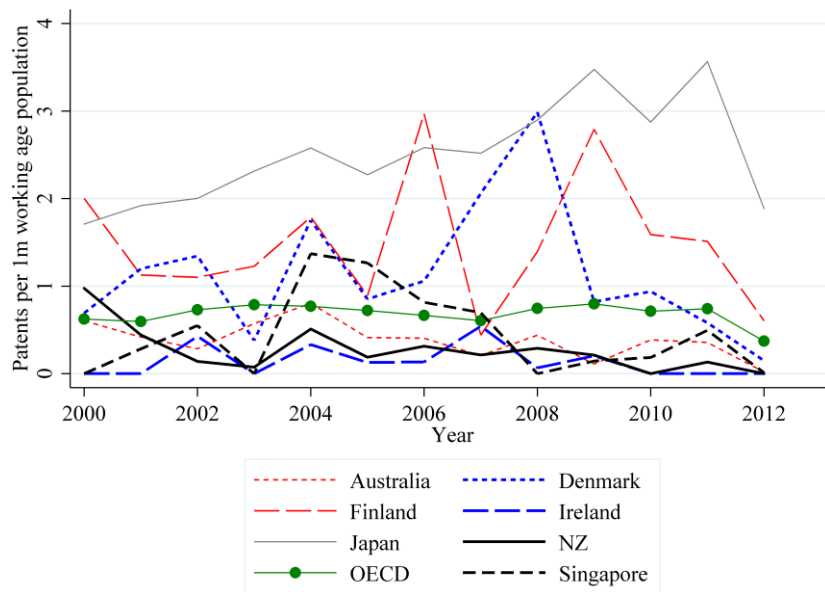
Panel D: Textile & paper machines patents



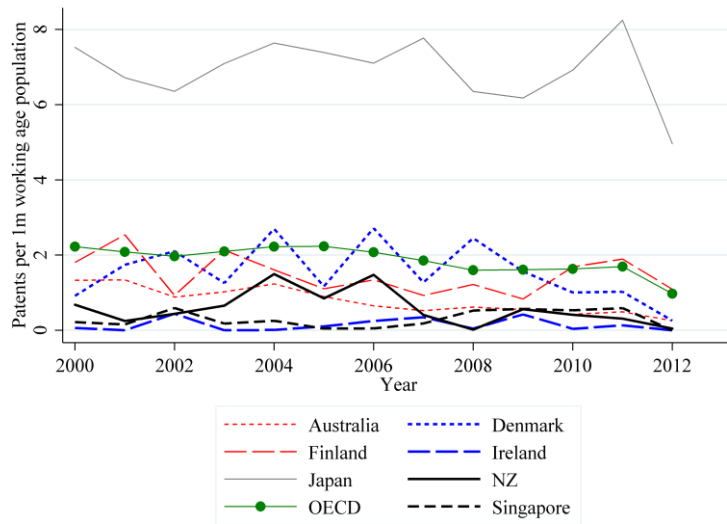
Panel E: Other special machines patents



Panel F: Thermal processes & apparatus patents



Panel G: Mechanical elements patents



Panel H: Transport patents

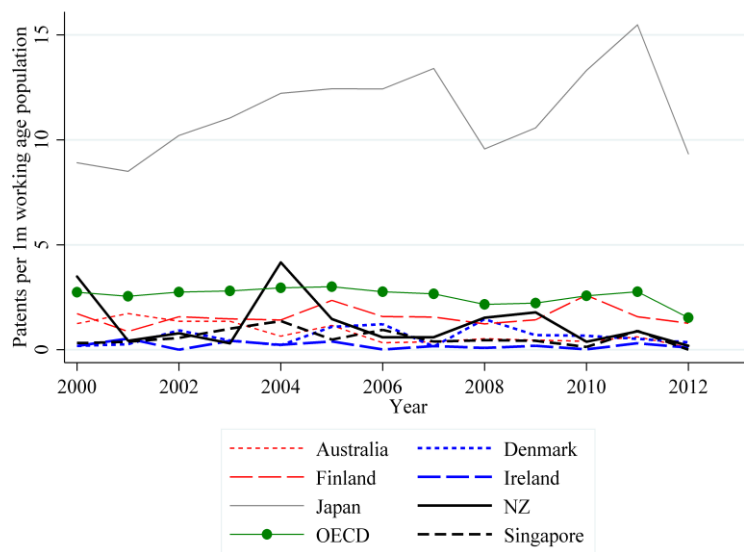
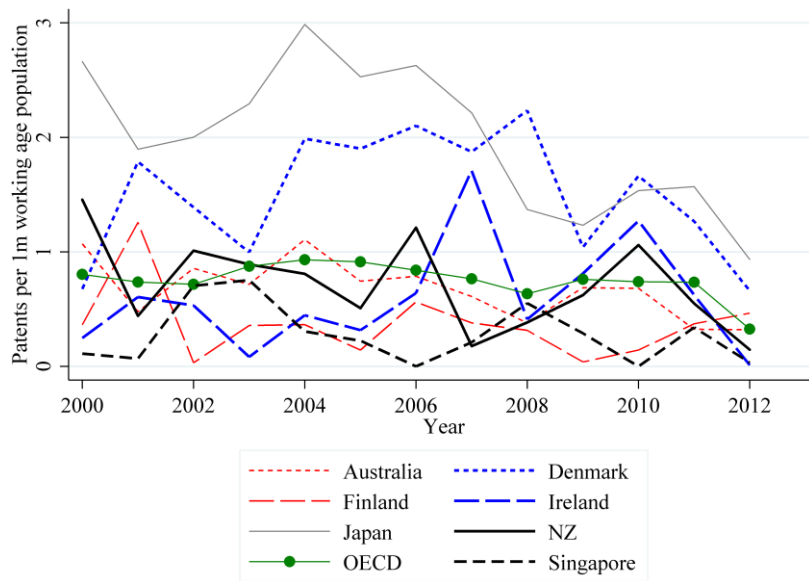
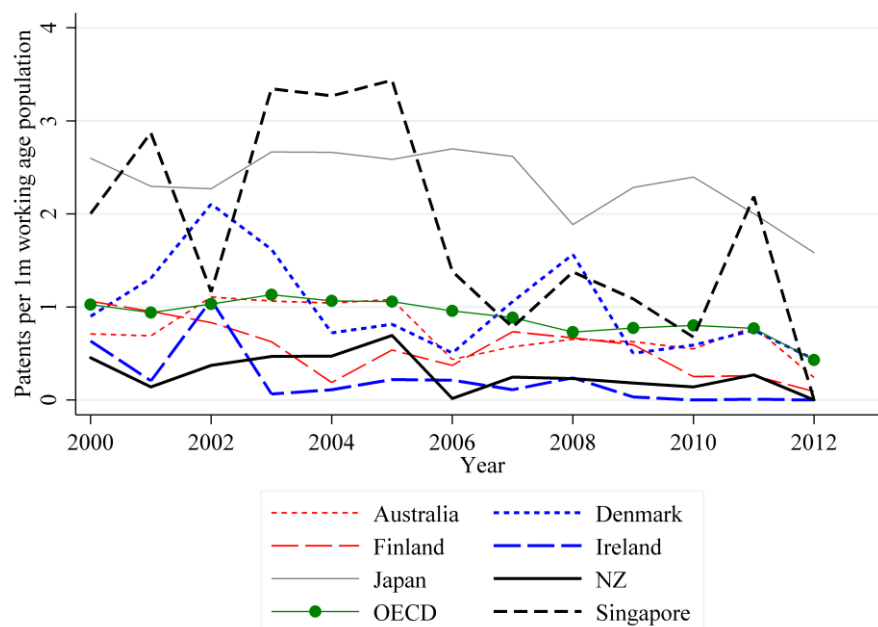


Figure 12: Other patents, NZ & other countries

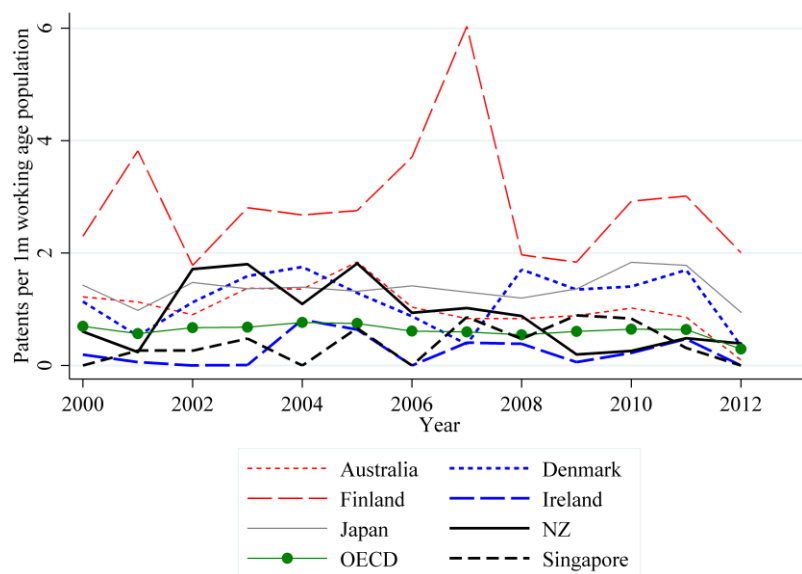
Panel A: Furniture & games patents



Panel B: Other consumer goods patents



Panel C: Civil engineering patents



Notes: Patent counts by technology field come from the OECD Main Science and Technology Indicators (MSTI) dataset. Data on working age populations come from the OECD Demography and Population dataset. We use the World Intellectual Property Office (WIPO) concordance tables to map International Patent Classification (IPC) codes to the technology types presented. These technology types have been constructed in order to be comparable across different countries. See http://www.wipo.int/export/sites/www/ipstats/en/statistics/patents/pdf/wipo_ipc_technology.pdf for details.

Research and Commercial Innovation in New Zealand: Background Report for SfTI Industry-Led Discussions

Appendix II

Motu Economic and Public Policy Research

April 2017

Adam Jaffe

Motu Economic and Public Policy Research and Queensland University of Technology
adam.jaffe@motu.org.nz

Nathan Chappell

Motu Economic and Public Policy Research
nathan.chappell@motu.org.nz

Tables

Table 1: R&D intensity and R&D scope in selected industries	3
Table 2: Proportion of firms engaging with CRIs & universities regarding R&D needs	8
Table 3: Type of R&D spending	13
Table 4: Proportion of firms reporting innovation & other activities	18
Table 5: Nascent and growing industries	23

Introduction

These appendix tables supplement the main report by showing more comprehensive breakdowns of industry R&D and commercial activity. Tables 1-3 use Statistics NZ's 2004-2014 Research and Development surveys, while Table 4 uses Statistics NZ's 2005-2015 Business Operations Surveys (BOS). Standard errors, in parentheses, capture the uncertainty in estimating population values from survey data. Table 5 uses population data to present descriptive statistics, and so standard errors in Table 5 are zero.

Table 1: R&D intensity and R&D scope in selected industries

Lvl 1 industry	Lvl 2 industry	Lvl 3/4 industry	R&D intensity	R&D intensity among performers	R&D personnel intensity	R&D personnel intensity among performers	Average yearly R&D (\$m)
Agriculture, forestry & fishing			0.001	0.034	0.003	0.090	\$17.0m
				(0.004)		(0.014)	(\$3.1m)
	Agriculture		0.000	0.037	0.003	0.173	\$5.8m
				(0.008)		(0.034)	(\$1.3m)
	Aquaculture		0.006	0.058	0.015	0.104	\$0.6m
				(0.026)		(0.043)	(\$0.2m)
	Forestry & logging		0.000	0.009	0.002	0.062	\$0.7m
				(0.005)		(0.029)	(\$0.3m)
	Fishing & hunting		0.000	0.007	0.001	0.211	\$0.02m
				(0.000)		(0.000)	(\$0.02m)
	Agr support services		0.003	0.038	0.006	0.053	(\$9.9m)
				(0.006)		(0.011)	(\$2.8m)
Mining			0.003	0.015	0.006	0.025	\$12.4m
				(0.006)		(0.007)	(\$6.3m)
	Coal mining		0.009	0.013	0.008	0.014	\$7.4m
				(0.008)		(0.008)	(\$6.0m)
	Metal ore mining		0.003	0.008	0.012	0.035	\$1.7m
				(0.002)		(0.006)	(\$0.8m)
	Non-metallic mining		0.001	0.024	0.005	0.089	\$0.5m
				(0.003)		(0.005)	(\$0.3m)
Manufacturing			0.004	0.012	0.021	0.064	\$375.2m

			(0.001)		(0.005)	(\$23.2m)
Lvl 2 industry	Lvl 3/4 industry	R&D intensity	R&D intensity among performers	R&D personnel intensity	R&D personnel intensity among performers	Average yearly R&D (\$m)
Food product manuf		0.002	0.004	0.010	0.020	\$70.2m
			(0.001)		(0.003)	(\$12.2m)
Beverage & tobac manuf		0.001	0.003	0.006	0.021	\$4.1m
			(0.001)		(0.003)	(\$1.2m)
Textile manuf		0.002	0.016	0.009	0.064	\$6.1m
			(0.002)		(0.008)	(\$0.8m)
Wood product manuf		0.001	0.017	0.005	0.059	\$3.5m
			(0.006)		(0.025)	(\$1.1m)
Pulp & paper manuf		0.001	0.002	0.005	0.018	\$2.3m
			(0.001)		(0.005)	(\$0.6m)
Printing		0.001	0.013	0.003	0.068	\$1.1m
			(0.001)		(0.028)	(\$0.4m)
Petrol & coal product		0.000	0.001	0.002	0.013	\$0.4m
			(0.001)		(0.007)	(\$0.3m)
Basic chemical manuf		0.004	0.011	0.030	0.085	\$17.1m
			(0.002)		(0.010)	(\$2.4m)
	Chemical manuf	0.003	0.016	0.041	0.122	\$3.1m
			(0.007)		(0.051)	(\$0.9m)
	Basic polymer manuf	0.002	0.008	0.008	0.070	\$0.9m
			(0.002)		(0.019)	(\$0.4m)
	Fertiliser & pesticide manuf	0.003	0.004	0.025	0.055	\$3.0m
			(0.001)		(0.014)	(0.7m)
	Pharma & med product manuf	0.007	0.018	0.029	0.075	\$5.5m
			(0.003)		(0.011)	(\$1.0m)
	Cleaning compound & toiletry prep manuf	0.006	0.014	0.031	0.077	\$3.5m

Lvl 2 industry	Lvl 3/4 industry	R&D intensity	R&D intensity among performers	R&D personnel intensity	R&D personnel intensity among performers	Average yearly R&D (\$m)
			(0.005)		(0.020)	(\$1.9m)
	Other chemical product manuf	0.010	0.063	0.119	0.368	\$1.1m
			(0.020)		(0.159)	(\$0.3m)
Polymer & rubber manuf		0.005	0.014	0.023	0.049	\$20.1m
			(0.002)		(0.005)	(\$2.3m)
Non-metallic product		0.001	0.005	0.008	0.040	\$3.4m
			(0.002)		(0.012)	(\$0.7m)
Metal product manuf		0.002	0.007	0.011	0.040	\$8.0m
			(0.002)		(0.013)	(\$2.8m)
Fabricated metal product		0.003	0.019	0.014	0.099	\$15.6m
			(0.004)		(0.010)	(\$2.1m)
Transport equip manuf		0.006	0.042	0.025	0.139	\$13.9m
			(0.007)		(0.018)	(\$2.1m)
Machinery & equip manuf		0.030	0.062	0.087	0.186	\$204.0m
			(0.005)		(0.010)	(\$19.1m)
	Prof & science equip manuf	0.074	0.104	0.168	0.253	\$51.3m
			(0.009)		(0.019)	(\$14.5m)
	Comp & electr equip manuf	0.092	0.132	0.222	0.305	\$78.4m
			(0.018)		(0.028)	(\$13.2m)
	Electrical equip manuf	0.012	0.023	0.052	0.099	\$12.4m
			(0.005)		(0.014)	(\$2.4m)
	Domestic appliance manuf	0.026	0.032	0.132	0.146	\$22.0m
			(0.006)		(0.024)	(\$8.2m)
	Pump,compressor,heating & ventilation manuf	0.036	0.053	0.065	0.085	\$9.8m
			(0.012)		(0.017)	(\$2.7m)
	Specialised machinery & equip manuf	0.012	0.036	0.055	0.161	\$13.0m

Lvl 1 industry	Lvl 2 industry	Lvl 3/4 industry	R&D intensity	R&D intensity among performers	R&D personnel intensity	R&D personnel intensity among performers	Average yearly R&D (\$m)
				(0.005)		(0.022)	(\$2.2m)
		Other machinery & equip manuf	0.009	0.039	0.028	0.144	\$17.2m
				(0.004)		(0.014)	(\$2.4m)
	Furniture & other manuf		0.003	0.027	0.017	0.139	\$5.4m
				(0.004)		(0.038)	(\$1.0m)
	Information media & telecommunications		0.002	0.028	0.010	0.121	\$21.0m
				(0.009)		(0.054)	(\$5.2m)
	Publishing (excl internet & music)		0.002	0.020	0.007	0.057	\$2.4m
				(0.011)		(0.048)	(\$0.7m)
	Motion picture & sound		0.006	0.067	0.035	0.747	\$9.2m
				(0.008)		(0.356)	(\$4.3m)
	Broadcasting (excl internet)		0.000	0.001	0.001	0.014	\$0.4m
				(0.000)		(0.002)	(\$0.3m)
	Telecom services		0.001	0.048	0.003	0.095	\$4.6m
				(0.019)		(0.026)	(\$2.3m)
	ISPs & other info services		0.003	0.055	0.015	0.291	\$2.7m
				(0.017)		(0.076)	(\$0.9m)
	Library & other info services		0.024	0.047	0.078	0.166	\$1.6m
				(0.019)		(0.067)	(\$1.1m)
	Professional, scientific & technical services		0.032	0.264	0.072	0.428	\$921.8m
				(0.039)		(0.025)	(\$62.3m)
	Professional & technical serv		0.030	0.265	0.061	0.398	\$741.3m
				(0.049)		(0.030)	(\$60.9m)
		Scientific research serv	0.449	0.659	0.586	0.622	\$653.5m
				(0.047)		(0.024)	(\$60.3m)
		Engineering design & consulting serv	0.008	0.075	0.046	0.265	\$27.5m

Lvl 1 industry	Lvl 2 industry	Lvl 3/4 industry	R&D intensity	R&D intensity among performers	R&D personnel intensity	R&D personnel intensity among performers	Average yearly R&D (\$m)
		Scientific testing & analysis serv	0.050	0.161	0.089	0.266	\$22.6m
				(0.015)		(0.102)	(\$5.4m)
				(0.034)		(0.043)	(\$4.1m)
	Computer systems design		0.037	0.259	0.130	0.524	\$180.5m
				(0.022)		(0.026)	(\$12.9m)
	Health care & social assistance		0.001	0.004	0.003	0.015	\$25.4m
				(0.001)		(0.002)	(\$4.4m)
	Hospitals		0.001	0.003	0.006	0.011	\$17.7m
				(0.000)		(0.001)	(\$3.9m)
	Medical care services		0.001	0.031	0.003	0.124	\$4.4m
				(0.009)		(0.031)	(\$1.3m)
		Pathology & diagnostic imaging serv	0.000	0.009	0.000	0.007	\$0.05m
				(0.001)		(0.001)	(\$0.03)
	Residential care services		0.000	0.028	0.000	0.016	\$0.4m
				(0.008)		(0.004)	(\$0.3m)
	Social assistance services		0.002	0.067	0.002	0.048	\$2.9m
				(0.031)		(0.022)	(\$1.7m)
Observations			16,650	5,655	16,650	5,676	16,650
Pop size			208,590	11,616	208,590	11,649	208,590

Notes: This table shows the R&D intensity and R&D scope of selected industries. Sample statistics use survey weights from the R&D surveys to estimate population values (e.g. the sum of R&D expenditure in an industry). Standard errors are in parentheses. R&D expenditure and personnel data come from the pooled 2004-2014 R&D surveys. Data on industry sales and industry employment come from administrative data. Standard errors are not presented for R&D intensity and R&D personnel intensity – these standard errors are small because the denominator of industry sales dominates the proportion and is known with certainty.

Table 2: Proportion of firms engaging with CRIs & universities regarding R&D needs

Lvl 1 industry	Lvl 2 industry	Lvl 3/4 industry	Any engagement with CRI/uni	No need to engage more with CRI/uni	Didn't know how to contact to engage more	Not enough expertise in CRI/uni to engage more	Too expensive to engage more
Agriculture, forestry & fishing			0.089 (0.019)	0.582 (0.035)	0.150 (0.025)	0.161 (0.027)	0.068 (0.017)
	Agriculture		0.097 (0.023)	0.575 (0.038)	0.142 (0.028)	0.167 (0.030)	0.075 (0.020)
	Aquaculture		0.040 (0.036)	0.147 (0.126)	0.029 (0.028)	0.732 (0.194)	0.066 (0.052)
	Forestry & logging		0.052 (0.026)	0.310 (0.201)	0.008 (0.006)	0.232 (0.199)	0.008 (0.006)
	Fishing & hunting		0.451 (0.190)	0.400 (0.198)	0.138 (0.105)	0.062 (0.064)	0.062 (0.064)
	Agr support services		0.047 (0.017)	0.705 (0.085)	0.229 (0.079)	0.083 (0.051)	0.041 (0.030)
Mining			0.356 (0.230)	0.831 (0.078)	0.021 (0.014)	0.038 (0.022)	0.013 (0.009)
	Coal mining		0.050 (0.057)	0.723 (0.194)	0.073 (0.082)	0.000 (0.000)	0.000 (0.000)
	Metal ore mining		0.122 (0.084)	0.515 (0.156)	0.000 (0.000)	0.326 (0.160)	0.000 (0.000)
	Non-metallic mining		0.475 (0.330)	0.949 (0.037)	0.016 (0.015)	0.007 (0.008)	0.007 (0.008)
Manufacturing			0.117 (0.010)	0.593 (0.020)	0.130 (0.014)	0.147 (0.013)	0.090 (0.009)
	Food product manuf		0.229 (0.057)	0.536 (0.072)	0.072 (0.040)	0.066 (0.021)	0.133 (0.036)

	Lvl 2 industry	Lvl 3/4 industry	Any engagement with CRI/uni	No need to engage more with CRI/uni	Didn't know how to contact to engage more	Not enough expertise in CRI/uni to engage more	Too expensive to engage more
Beverage & tobac manuf			0.077 (0.035)	0.388 (0.171)	0.197 (0.145)	0.030 (0.017)	0.023 (0.014)
Textile manuf			0.059 (0.008)	0.720 (0.065)	0.101 (0.057)	0.043 (0.008)	0.022 (0.006)
Wood product manuf			0.051 (0.016)	0.676 (0.072)	0.112 (0.054)	0.157 (0.057)	0.013 (0.004)
Pulp & paper manuf			0.259 (0.086)	0.534 (0.095)	0.052 (0.050)	0.130 (0.062)	0.134 (0.061)
Printing			0.046 (0.041)	0.788 (0.071)	0.276 (0.085)	0.147 (0.068)	0.003 (0.002)
Petrol & coal product			0.285 (0.130)	0.693 (0.133)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Basic chemical manuf			0.284 (0.050)	0.460 (0.070)	0.067 (0.018)	0.085 (0.019)	0.327 (0.069)
		Chemical manuf	0.648 (0.119)	0.357 (0.111)	0.000 (0.000)	0.243 (0.098)	0.194 (0.089)
		Basic polymer manuf	0.398 (0.230)	0.254 (0.125)	0.031 (0.032)	0.020 (0.021)	0.654 (0.155)
		Fertiliser & pesticide manuf	0.298 (0.108)	0.492 (0.172)	0.036 (0.021)	0.035 (0.020)	0.398 (0.170)
		Pharma & med product manuf	0.307 (0.080)	0.583 (0.096)	0.130 (0.052)	0.075 (0.030)	0.200 (0.062)
		Cleaning compound & toiletry prep manuf	0.104 (0.059)	0.680 (0.128)	0.108 (0.057)	0.090 (0.051)	0.115 (0.060)

Lvl 2 industry	Lvl 3/4 industry	Any engagement with CRI/uni	No need to engage more with CRI/uni	Didn't know how to contact to engage more	Not enough expertise in CRI/uni to engage more	Too expensive to engage more
	Other chemical product manuf	0.188 (0.086)	0.149 (0.092)	0.016 (0.017)	0.182 (0.099)	0.444 (0.196)
	Polymer & rubber manuf		0.158 (0.024)	0.484 (0.045)	0.105 (0.068)	0.282 (0.047)
	Non-metallic product	0.081 (0.017)	0.639 (0.046)	0.130 (0.026)	0.089 (0.035)	0.065 (0.020)
	Metal product manuf	0.235 (0.098)	0.667 (0.078)	0.083 (0.039)	0.057 (0.030)	0.038 (0.028)
	Fabricated metal product		0.071 (0.019)	0.616 (0.031)	0.140 (0.036)	0.185 (0.024)
	Transport equip manuf		0.038 (0.011)	0.565 (0.038)	0.106 (0.049)	0.175 (0.034)
	Machinery & equip manuf	0.150 (0.019)	0.560 (0.035)	0.126 (0.023)	0.194 (0.029)	0.100 (0.018)
	Prof & science equip manuf	0.227 (0.056)	0.557 (0.099)	0.067 (0.028)	0.280 (0.104)	0.060 (0.023)
	Comp & electr equip manuf	0.322 (0.076)	0.362 (0.082)	0.140 (0.066)	0.251 (0.083)	0.310 (0.082)
	Electrical equip manuf	0.072 (0.027)	0.546 (0.108)	0.125 (0.074)	0.145 (0.083)	0.052 (0.022)
	Domestic appliance manuf	0.372 (0.112)	0.404 (0.125)	0.248 (0.101)	0.000 (0.000)	0.170 (0.082)
	Pump,compressor,heating & ventilation	0.182 (0.088)	0.327 (0.129)	0.000 (0.000)	0.387 (0.204)	0.079 (0.062)

Lvl 1 industry	Lvl 2 industry	Lvl 3/4 industry	Any engagement with CRI/uni	No need to engage more with CRI/uni	Didn't know how to contact to engage more	Not enough expertise in CRI/uni to engage more	Too expensive to engage more
		Specialised machinery & equip manuf	0.109 (0.040)	0.644 (0.074)	0.080 (0.035)	0.154 (0.055)	0.121 (0.047)
		Other machinery & equip manuf	0.118 (0.030)	0.588 (0.055)	0.166 (0.044)	0.187 (0.046)	0.053 (0.019)
	Furniture & other manuf			0.068 (0.020)	0.519 (0.066)	0.200 (0.073)	0.196 (0.055)
		Information media & telecommunications		0.075 (0.022)	0.802 (0.009)	0.030 (0.077)	0.154 (0.010)
	Publishing (excl internet & music)			0.070 (0.035)	0.775 (0.009)	0.017 (0.128)	0.150 (0.008)
	Motion picture & sound			0.161 (0.095)	0.701 (0.143)	0.046 (0.077)	0.116 (0.040)
	Broadcasting (excl internet)			0.015 (0.018)	0.942 (0.000)	0.000 (0.000)	0.000 (0.000)
	Telecom services			0.035 (0.028)	0.903 (0.061)	0.027 (0.021)	0.468 (0.284)
	ISPs & other info services			0.071 (0.042)	0.800 (0.027)	0.049 (0.016)	0.025 (0.039)
	Library & other info services			0.000 (0.000)	1.000 (0.000)	0.000 (0.000)	0.000 (0.000)
		Professional, scientific & technical services			0.104 (0.010)	0.672 (0.017)	0.053 (0.012)
	Professional & technical serv			0.100 (0.015)	0.684 (0.030)	0.041 (0.012)	0.063 (0.015)

Lvl 1 industry	Lvl 2 industry	Lvl 3/4 industry	Any engagement with CRI/uni	No need to engage more with CRI/uni	Didn't know how to contact to engage more	Not enough expertise in CRI/uni to engage more	Too expensive to engage more
		Scientific research serv	0.513 (0.029)	0.348 (0.025)	0.054 (0.012)	0.181 (0.023)	0.164 (0.019)
		Engineering design & consulting serv	0.138 (0.031)	0.548 (0.070)	0.047 (0.034)	0.168 (0.050)	0.123 (0.059)
		Scientific testing & analysis serv	0.428 (0.076)	0.490 (0.072)	0.083 (0.028)	0.301 (0.073)	0.233 (0.064)
	Computer systems design			0.118 (0.014)	0.620 (0.014)	0.105 (0.016)	0.131 (0.013)
Health care & social assistance				0.027 (0.010)	0.697 (0.035)	0.159 (0.027)	0.091 (0.014)
	Hospitals		0.017 (0.021)	0.712 (0.178)	0.014 (0.016)	0.014 (0.016)	0.000 (0.000)
	Medical care services		0.018 (0.005)	0.720 (0.054)	0.152 (0.044)	0.084 (0.034)	0.030 (0.017)
		Pathology & diagnostic imaging serv	0.000 (0.000)	0.432 (0.205)	0.000 (0.000)	0.415 (0.216)	0.000 (0.000)
	Residential care services			0.012 (0.007)	0.706 (0.075)	0.113 (0.088)	0.168 (0.006)
	Social assistance services			0.070 (0.045)	0.617 (0.087)	0.227 (0.049)	0.056 (0.042)
Observations			8,019	8,808	8,808	8,808	8,808
Pop size			65142	68574	68574	68574	68574

Notes: This table presents estimates of industry engagement with CRIs and universities, from the pooled 2004-2014 R&D surveys. Standard errors are in parentheses.

Table 3: Type of R&D spending

Lvl 1 industry	Lvl 2 industry	Lvl 3/4 industry	Prop. of R&D spending that is applied	Prop. of R&D spending that is experimental	Prop. of R&D spending that is basic
Agriculture, forestry & fishing			0.296	0.376	0.107
			(0.074)	(0.076)	(0.065)
	Agriculture		0.322	0.338	0.048
			(0.087)	(0.079)	(0.019)
	Aquaculture		0.477	0.445	0.078
			(0.122)	(0.117)	(0.060)
	Forestry & logging		0.392	0.486	0.122
			(0.085)	(0.124)	(0.076)
	Fishing & hunting		0.000	1.000	0.000
			(0.000)	(0.000)	(0.000)
	Agr support services		0.168	0.496	0.336
			(0.078)	(0.212)	(0.233)
Mining			0.343	0.633	0.024
			(0.101)	(0.106)	(0.015)
	Coal mining		0.370	0.587	0.043
			(0.126)	(0.147)	(0.022)
	Metal ore mining		0.626	0.374	0.000
			(0.133)	(0.133)	(0.000)
	Non-metallic mining		0.061	0.908	0.031
			(0.062)	(0.093)	(0.031)
Manufacturing			0.233	0.636	0.060
			(0.017)	(0.037)	(0.007)

Lvl 2 industry	Lvl 3/4 industry	Prop. of R&D spending that is applied	Prop. of R&D spending that is experimental	Prop. of R&D spending that is basic
Food product manuf		0.186 (0.028)	0.717 (0.035)	0.092 (0.021)
Beverage & tobac manuf		0.188 (0.052)	0.752 (0.059)	0.060 (0.028)
Textile manuf		0.212 (0.060)	0.574 (0.101)	0.046 (0.015)
Wood product manuf		0.232 (0.106)	0.730 (0.112)	0.038 (0.023)
Pulp & paper manuf		0.250 (0.068)	0.650 (0.078)	0.099 (0.048)
Printing		0.044 (0.042)	0.100 (0.087)	0.005 (0.005)
Petrol & coal product		0.159 (0.124)	0.828 (0.125)	0.013 (0.012)
Basic chemical manuf		0.358 (0.031)	0.606 (0.028)	0.033 (0.007)
	Chemical manuf	0.340 (0.077)	0.615 (0.085)	0.045 (0.021)
	Basic polymer manuf	0.337 (0.095)	0.633 (0.096)	0.029 (0.014)
	Fertiliser & pesticide manuf	0.353 (0.058)	0.614 (0.058)	0.033 (0.010)
	Pharma & med product manuf	0.355 (0.046)	0.593 (0.046)	0.040 (0.013)
	Cleaning compound & toiletry prep manuf	0.410 (0.050)	0.577 (0.046)	0.013 (0.007)

	Other chemical product manuf	0.214 (0.037)	0.706 (0.053)	0.079 (0.022)
	Polymer & rubber manuf	0.283 (0.030)	0.631 (0.030)	0.060 (0.010)
		Prop. of R&D spending that is applied	Prop. of R&D spending that is experimental	Prop. of R&D spending that is basic
Lvl 2 industry	Lvl 3/4 industry			
	Non-metallic product	0.238 (0.039)	0.662 (0.050)	0.090 (0.028)
	Metal product manuf	0.142 (0.043)	0.776 (0.069)	0.082 (0.044)
	Fabricated metal product	0.153 (0.020)	0.753 (0.041)	0.066 (0.016)
	Transport equip manuf	0.234 (0.064)	0.646 (0.069)	0.114 (0.059)
	Machinery & equip manuf	0.265 (0.019)	0.686 (0.022)	0.048 (0.011)
	Prof & science equip manuf	0.356 (0.048)	0.606 (0.048)	0.038 (0.009)
	Comp & electr equip manuf	0.262 (0.048)	0.669 (0.050)	0.064 (0.041)
	Electrical equip manuf	0.224 (0.034)	0.690 (0.046)	0.086 (0.021)
	Domestic appliance manuf	0.221 (0.069)	0.757 (0.068)	0.022 (0.009)
	Pump,compressor,heating & ventilation manuf	0.308 (0.067)	0.644 (0.070)	0.048 (0.024)
	Specialised machinery & equip manuf	0.294 (0.033)	0.688 (0.033)	0.019 (0.005)

Lvl 1 industry	Lvl 2 industry	Lvl 3/4 industry	Prop. of R&D spending that is applied	Prop. of R&D spending that is experimental	Prop. of R&D spending that is basic
		Other machinery & equip manuf	0.237 (0.044)	0.716 (0.054)	0.047 (0.016)
		Furniture & other manuf	0.368 (0.108)	0.528 (0.100)	0.098 (0.045)
			0.345 (0.055)	0.530 (0.057)	0.118 (0.032)
		Publishing (excl internet & music)	0.517 (0.116)	0.389 (0.100)	0.086 (0.036)
		Motion picture & sound	0.267 (0.096)	0.537 (0.110)	0.196 (0.082)
		Broadcasting (excl internet)	0.147 (0.106)	0.803 (0.141)	0.049 (0.035)
		Telecom services	0.328 (0.101)	0.415 (0.106)	0.192 (0.094)
		ISPs & other info services	0.327 (0.092)	0.621 (0.096)	0.052 (0.025)
		Library & other info services	0.249 (0.125)	0.751 (0.125)	0.000 (0.000)
		Professional, scientific & technical services	0.373 (0.022)	0.481 (0.025)	0.085 (0.011)
		Professional & technical serv	0.409 (0.032)	0.401 (0.037)	0.093 (0.016)
		Scientific research serv	0.478 (0.019)	0.388 (0.018)	0.086 (0.010)
		Engineering design & consulting serv	0.344 (0.048)	0.540 (0.071)	0.048 (0.015)

Lvl 1 industry	Lvl 2 industry	Lvl 3/4 industry	Prop. of R&D spending that is applied	Prop. of R&D spending that is experimental	Prop. of R&D spending that is basic
		Scientific testing & analysis serv	0.441 (0.055)	0.424 (0.046)	0.129 (0.033)
	Computer systems design		0.314 (0.019)	0.610 (0.020)	0.072 (0.008)
			0.380 (0.104)	0.319 (0.103)	0.070 (0.024)
	Hospitals		0.513 (0.068)	0.179 (0.042)	0.128 (0.072)
		Medical care services	0.437 (0.139)	0.365 (0.140)	0.043 (0.021)
		Pathology & diagnostic imaging serv	0.504 (0.354)	0.000 (0.000)	0.496 (0.354)
	Residential care services		0.215 (0.083)	0.599 (0.158)	0.186 (0.109)
	Social assistance services		0.146 (0.086)	0.176 (0.105)	0.125 (0.087)
Observations			5,712	5,712	5,712
Pop size			12,489	12,489	12,489

Notes: This table presents estimates of the type of R&D spending by firms in different industries, using the pooled 2004-2014 R&D surveys. Standard errors are in parentheses. Proportions are calculated from firm-level data and are weighted by sample weights but not by firm R&D expenditure. Hence an estimated basic R&D proportion of 0.2 means the average firm in the industry is estimated to channel 20% of its R&D toward basic research, and not that 20% of the industry's R&D spending goes toward basic research.

Table 4: Proportion of firms reporting innovation & other activities

Lvl 1 industry	Lvl 2 industry	Lvl 3/4 industry	Any innovation in last year	Undertook or funded R&D in last year	Entered new export market in last year	Protects intellectual property in any way	Exports as % of sales in last year
Agriculture, forestry & fishing			0.262	0.068	0.041	0.232	22.6
			(0.012)	(0.006)	(0.005)	(0.011)	(1.1)
	Agriculture		0.256	0.076	0.054	0.245	30.7
			(0.015)	(0.008)	(0.007)	(0.014)	(1.6)
	Aquaculture		0.349	0.190	0.058	0.403	8.3
			(0.051)	(0.041)	(0.026)	(0.053)	(2.2)
	Forestry & logging		0.245	0.058	0.018	0.130	6.9
			(0.022)	(0.011)	(0.007)	(0.016)	(1.2)
	Fishing & hunting		0.305	0.157	0.155	0.366	21.3
			(0.050)	(0.041)	(0.038)	(0.049)	(3.4)
	Agr support services		0.278	0.041	0.009	0.214	2.7
			(0.019)	(0.008)	(0.003)	(0.018)	(0.8)
Mining			0.316	0.095	0.028	0.455	7.5
			(0.024)	(0.013)	(0.008)	(0.025)	(1.1)
	Coal mining		0.314	0.101	0.042	0.545	7.9
			(0.066)	(0.040)	(0.030)	(0.071)	(2.8)
	Metal ore mining		0.205	0.126	0.022	0.298	24.9
			(0.075)	(0.049)	(0.022)	(0.068)	(6.2)
	Non-metallic mining		0.288	0.079	0.023	0.379	2.7
			(0.032)	(0.018)	(0.009)	(0.036)	(1.0)
Manufacturing			0.444	0.189	0.119	0.586	13.5
			(0.008)	(0.006)	(0.005)	(0.008)	(0.4)

Lvl 2 industry	Lvl 3 industry	Any innovation in last year	Undertook or funded R&D in last year	Entered new export market in last year	Protects intellectual property in any way	Exports as % of sales in last year
Food product manuf		0.484 (0.023)	0.234 (0.017)	0.153 (0.014)	0.656 (0.024)	18.6 (1.3)
Beverage & tobac manuf		0.456 (0.046)	0.146 (0.031)	0.484 (0.046)	0.823 (0.036)	38.7 (2.8)
Textile manuf		0.401 (0.023)	0.144 (0.013)	0.119 (0.014)	0.599 (0.023)	16.5 (1.3)
Wood product manuf		0.346 (0.026)	0.096 (0.014)	0.079 (0.010)	0.371 (0.026)	9.9 (1.1)
Pulp & paper manuf		0.353 (0.048)	0.214 (0.037)	0.102 (0.025)	0.864 (0.037)	20.7 (3.0)
Printing		0.442 (0.026)	0.072 (0.010)	0.033 (0.007)	0.498 (0.026)	3.7 (0.5)
Petrol & coal product		0.526 (0.121)	0.240 (0.082)	0.000 (0.000)	0.954 (0.033)	4.3 (2.1)
Basic chemical manuf		0.510 (0.038)	0.369 (0.036)	0.178 (0.028)	0.828 (0.031)	26.3 (2.9)
	Chemical manuf	0.400 (0.101)	0.367 (0.105)	0.187 (0.069)	0.933 (0.050)	16.3 (6.0)
	Basic polymer manuf	0.368 (0.090)	0.207 (0.063)	0.186 (0.072)	0.607 (0.100)	16.9 (4.9)
	Fertiliser & pesticide manuf	0.596 (0.091)	0.553 (0.090)	0.198 (0.076)	0.978 (0.022)	6.7 (2.1)
	Pharma & med product manuf	0.615 (0.065)	0.508 (0.066)	0.165 (0.038)	0.891 (0.045)	43.7 (5.6)
	Cleaning compound & toiletry prep manuf	0.508	0.162	0.223	0.687	16.2

	(0.089)	(0.073)	(0.086)	(0.085)	(3.2)
Other chemical product manuf	0.400	0.367	0.187	0.933	16.3
	(0.101)	(0.105)	(0.069)	(0.050)	(6.0)

Lvl 2 industry	Lvl 3/4 industry	Any innovation in last year	Undertook or funded R&D in last year	Entered new export market in last year	Protects intellectual property in any way	Exports as % of sales in last year
Polymer & rubber manuf		0.514	0.312	0.184	0.714	14.5
		(0.031)	(0.026)	(0.024)	(0.031)	(1.3)
Non-metallic product		0.487	0.223	0.039	0.585	2.5
		(0.028)	(0.023)	(0.010)	(0.028)	(0.5)
Metal product manuf		0.496	0.297	0.133	0.673	19.4
		(0.072)	(0.059)	(0.042)	(0.075)	(2.9)
Fabricated metal product		0.349	0.115	0.034	0.495	4.3
		(0.020)	(0.012)	(0.007)	(0.021)	(0.5)
Transport equip manuf		0.436	0.171	0.101	0.512	12.1
		(0.039)	(0.025)	(0.019)	(0.038)	(1.7)
Machinery & equip manuf		0.500	0.307	0.166	0.654	19.0
		(0.021)	(0.019)	(0.015)	(0.021)	(1.1)
	Prof & science equip manuf	0.621	0.463	0.315	0.773	46.6
		(0.054)	(0.053)	(0.052)	(0.050)	(5.0)
	Comp & electr equip manuf	0.686	0.491	0.323	0.814	36.4
		(0.048)	(0.047)	(0.041)	(0.044)	(3.7)
	Electrical equip manuf	0.614	0.379	0.166	0.744	18.1
		(0.038)	(0.040)	(0.030)	(0.036)	(1.9)
	Domestic appliance manuf	0.498	0.467	0.082	0.907	10.8
		(0.083)	(0.084)	(0.030)	(0.045)	(2.3)
	Pump,compressor,heating & ventilation manuf	0.361	0.346	0.340	0.568	34.5
		(0.110)	(0.111)	(0.112)	(0.114)	(8.7)

Lvl 1 industry	Lvl 2 industry	Lvl 3/4 industry	Any innovation in last year	Undertook or funded R&D in last year	Entered new export market in last year	Protects intellectual property in any way	Exports as % of sales in last year
		Specialised machinery & equip manuf	0.594 (0.052)	0.350 (0.049)	0.203 (0.042)	0.683 (0.049)	20.0 (2.4)
		Other machinery & equip manuf	0.396 (0.033)	0.206 (0.028)	0.088 (0.018)	0.573 (0.034)	10.4 (1.4)
	Furniture & other manuf		0.553 (0.030)	0.131 (0.015)	0.073 (0.016)	0.564 (0.030)	8.7 (1.4)
		Information media & telecommunications		0.537 (0.019)	0.140 (0.012)	0.053 (0.017)	0.7 (0.6)
		Publishing (excl internet & music)	0.498 (0.036)	0.130 (0.022)	0.039 (0.014)	0.743 (0.034)	5.5 (1.2)
		Motion picture & sound	0.496 (0.034)	0.073 (0.016)	0.068 (0.015)	0.602 (0.032)	4.8 (0.9)
		Broadcasting (excl internet)	0.501 (0.057)	0.141 (0.042)	0.008 (0.008)	0.763 (0.055)	0.1 (0.0)
		Telecom services	0.628 (0.047)	0.183 (0.035)	0.054 (0.038)	0.731 (0.047)	3.7 (1.3)
		ISPs & other info services	0.686 (0.033)	0.279 (0.034)	0.088 (0.026)	0.886 (0.022)	8.56 (1.8)
		Library & other info services	1.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.773 (0.202)	1.6 (1.4)
		Professional, scientific & technical services	0.406 (0.014)	0.130 (0.008)	0.051 (0.005)	0.587 (0.014)	6.8 (0.6)
		Professional & technical serv	0.364 (0.016)	0.086 (0.009)	0.031 (0.005)	0.525 (0.017)	4.3 (0.6)
		Scientific research serv	0.311 (0.115)	0.416 (0.133)	0.184 (0.085)	0.435 (0.129)	49.7 (14.5)

Lvl 1 industry	Lvl 2 industry	Lvl 3/4 industry	Any innovation in last year	Undertook or funded R&D in last year	Entered new export market in last year	Protects intellectual property in any way	Exports as % of sales in last year
		Engineering design & consulting serv	0.464 (0.050)	0.225 (0.043)	0.069 (0.023)	0.718 (0.045)	13.2 (3.4)
		Scientific testing & analysis serv	0.507 (0.106)	0.118 (0.037)	0.072 (0.029)	0.720 (0.096)	14.8 (3.9)
	Computer systems design		0.621 (0.021)	0.356 (0.020)	0.155 (0.016)	0.906 (0.012)	19.4 (1.4)
	Health care & social assistance		0.393 (0.015)	0.034 (0.006)	0.002 (0.001)	0.413 (0.015)	0.2 (0.1)
	Hospitals		0.340 (0.049)	0.040 (0.014)	0.004 (0.004)	0.354 (0.045)	0.0 (0.0)
	Medical care services		0.392 (0.021)	0.032 (0.007)	0.002 (0.002)	0.467 (0.022)	0.2 (0.2)
		Pathology & diagnostic imaging serv	0.341 (0.071)	0.004 (0.004)	0.000 (0.000)	0.378 (0.068)	0.0 (0.0)
	Residential care services		0.340 (0.028)	0.022 (0.009)	0.001 (0.001)	0.328 (0.025)	0.0 (0.0)
Observations			24,381	24,657	25,062	25,068	22,869
Pop size			116,190	118,200	119,082	119,022	108,699

Notes: This table presents estimates of industry innovation and other activities from the pooled 2005-2015 BOS innovation module surveys. Standard errors are in parentheses. Proportions are calculated from firm-level data and are weighted by sample weights only. Hence an estimated export intensity of 5% means the average firm in the industry has an export intensity of 5%, and not that industry exports make up 5% of industry sales.

Table 5: Nascent and growing industries

Lvl 1 industry	Lvl 2 industry	Lvl 3/4 industry	Proportion of firms aged 2 years or younger	% change in sales, 2005-2015	Average no. of firms in a year
Agriculture, forestry & fishing					
	Agriculture		0.107	14.3	22,269
	Aquaculture		0.104	-14.5	72
	Forestry & logging		0.191	37.4	660
	Fishing & hunting		0.117	14.9	468
	Agr support services		0.207	31.3	2,961
Mining					
	Coal mining		0.134	-12.7	21
	Metal ore mining		0.296	263.7	39
	Non-metallic mining		0.121	6.5	138
Manufacturing					
	Food product manuf		0.240	22.1	2,049
	Beverage & tobac manuf		0.154	8.0	318
	Textile manuf		0.123	-30.0	999
	Wood product manuf		0.104	-11.8	1,218
	Pulp & paper manuf		0.094	-23.8	66
	Printing		0.140	-36.7	840
	Petrol & coal product		0.197	-27.9	21
	Basic chemical manuf		0.151	-20.0	315
		Chemical manuf	0.137	-7.1	27
		Basic polymer manuf	0.240	-44.8	36

Lvl 1 industry	Lvl 2 industry	Lvl 3/4 industry	Proportion of firms aged 2 years or younger	% change in sales, 2005-2015	Average no. of firms in a year
		Fertiliser & pesticide manuf	0.133	-42.5	54
		Pharma & med product manuf	0.133	65.5	81
		Cleaning compound & toiletry prep manuf	0.139	-46.3	84
		Other chemical product manuf	0.165	11.5	36
	Polymer & rubber manuf		0.094	-19.3	510
	Non-metallic product		0.172	0.0	456
	Metal product manuf		0.122	29.7	132
	Fabricated metal product		0.102	-5.6	1,941
	Transport equip manuf		0.134	-16.1	795
	Machinery & equip manuf		0.131	-11.1	2,046
		Prof & science equip manuf	0.127	-5.0	207
		Comp & electr equip manuf	0.097	-2.8	165
		Electrical equip manuf	0.122	-12.3	183
		Domestic appliance manuf	0.227	-44.9	36
		Pump,compressor,heating & ventilation manuf	0.113	7.2	48
		Specialised machinery & equip manuf	0.089	3.0	345
		Other machinery & equip manuf	0.150	-9.1	1,062
	Furniture & other manuf		0.124	-29.0	1,200
Information media & telecommunications					
	Publishing (excl internet & music)		0.182	15.0	426
	Motion picture & sound		0.202	34.7	534
	Broadcasting (excl internet)		0.423	2482.2	36
	Telecom services		0.367	13.5	135
	ISPs & other info services		0.289	-15.2	249
	Library & other info services		0.123	-83.4	24

Professional, scientific & technical services					
Lvl 1 industry	Lvl 2 industry	Lvl 3/4 industry	Proportion of firms aged 2 years or younger	% change in sales, 2005-2015	Average no. of firms in a year
	Professional & technical serv		0.175	3.4	14,895
		Scientific research serv	0.196	27.2	219
		Engineering design & consulting serv	0.207	53.0	1,629
		Scientific testing & analysis serv	0.138	4.1	240
	Computer systems design		0.208	52.3	3,000
Health care & social assistance					
	Hospitals		0.063	43.0	99
	Medical care services		0.131	52.4	6,042
	Residential care services		0.094	55.1	765
	Social assistance services		0.183	1.9	1,986

Observations

Pop size

Notes: This table shows indicators of how young the firms in different industries are, and of industry growth in sales and employment (weighted by sales and employment respectively). Statistics are shown separately for industries of interest. No standard errors are presented as this is population data - there is no uncertainty in extrapolating from sample statistics to population statistics. Industries classified by the ANZSIC 2006 system.