

Digital Research Reports

The Fourth Age of Research in Australasia

An analysis of international collaboration patterns in Australia and New Zealand.

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The Fourth Age of Research in Australasia

In 2013, Adams argued, based on a 30-year time slice of data from Web of Science, that research was becoming increasingly internationally collaborative¹. He coined the term “The Fourth Age of Research” to describe this effect, classifying the first, second and third ages of research as centring around research that involves only the resource of an individual (uncollaborative), institution-level resources, and collaboration and national-level resources respectively. In his study, Adams defined international collaboration in terms of internationally collaborative papers.

There are many drivers of this trend toward international collaboration. Researchers are often taught that a good researcher should be able to: i) come up with a cogent formulation of a research project; ii) design the data collection methodology; iii) understand the ethical landscape and implications of the project; iv) write the project proposal and obtain funding; v) build the data collection mechanism; vi) perform the data collection; vii) analyse the data and perform the correct statistical calculations to understand the errors; viii) interpret the data; ix) comprehend the significance of the data; x) write up the narrative and results and publish them in a leading journal as well as disseminate the results more broadly to ensure that they have the best chance of resulting in a socio-political, economic or societal benefit. However, this is clearly an unrealistic demand of most researchers in most fields given the current level of complexity of most important research problems. Indeed, there are few fields that are left where individual researchers can attempt to solve relevant problems in isolation.

A related line of argument can be used at institutional and national levels. The analogous problems are less centred around personal skills (although that can still be one of the drivers to seek collaborators in other institutions or countries) but are much more often to do with more tangible resource constraints such as access to specific equipment. At a low level this can be something as simple as access to equipment such as a scanning tunnelling electron microscope. At a higher level this might be access to an international piece of equipment such as the Parkes Observatory.

International collaboration is no longer simply the purview of “big science”. Famously, Fields Medallist Professor Sir Tim Gowers, of the University of Cambridge has worked to make Mathematics more collaborative through his Polymath blog². This type of approach has been taken to a new level with mathematicians working in collaboration to chunk down and check long and complex proofs of subtle theorems. Since 2013, the movement towards Internationally collaborative research has spread dramatically beyond elite science. Analysing these trends helps provide insight into the level of influence that different research economies are able to exercise over each other. In this short piece, we perform a high-level analysis of the influences that are emerging in the Australasian region.

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¹ Adams, J *The fourth age of research*, *Nature* 497, p557-560, 2013 <https://doi.org/10.1038/497557a>.

² <https://polymathprojects.org/>

Analyses

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In the current report, we take a new look at international collaboration patterns focussing on the Australasian region. More than other regions in the world, Australasia has always been outward looking and its research community has sought to connect itself with international partners. This is, no doubt, in part due to the geographical location of the continent but other factors play a role including the heavy development of Australasia's research base in the last few years and the importance and power of that research base as an economic driver for the region. More recently, a coherent focus has been taken across the region to international engagement.

We have used Digital Science's Dimensions database³ together with a filter of high-quality journals provided by the Nature Index⁴ journal list to explore the national and international collaboration landscape in Australia and New Zealand.

Dimensions is a data source that includes publication, citation, awarded grant, patent, policy and clinical trial data, fully integrated into a single searchable index. Dimensions focuses on an approach to data that ensures an inclusive approach to populating the database coupled with a modern approach to filtering data to ensure that the user remains in control of the research results with which they interact. Dimensions is also designed to bring more context to users, firstly, through the types of data that have been brought together and secondly, through the user interface and the ability to explore non-trivial aggregations and summaries of data⁵.

For the analyses that follow, we will focus on the publication and citation data index in Dimensions. The publication index includes journal articles, books, book chapters and conference proceedings. The criterion for a research output to be included in the index is that it must have a unique identifier such as a DOI⁶ or PubMed⁷ identifier. In addition, co-authors are mapped to their ORCID identifier using the publicly available data file and APIs that ORCID makes available^{8,9}. Finally, author affiliations are mapped to Digital Science's GRID database of institutional identifiers¹⁰.

As the Dimensions publication index is an inclusive index and does not make selections based on journal metrics, we present two versions of our analysis. One version of the analysis is based on the full Dimensions data – this forms a general and inclusive basis of analysis. To test the robustness of this inclusive dataset, we benchmarked the results shown below against the same analysis using the ERA2015 list as a filter – the results were almost indistinguishable. The second version is a selective dataset based on the Nature Index journal list¹¹ – we use this highly selective choice as a proxy for high-impact research.

³ <http://app.dimensions.ai>

⁴ <https://www.natureindex.com/>

⁵ Hook DW, Porter, SJ, Herzog C, *Dimensions: Building Context for Search and Evaluation*, *Front. Res. Metr. Anal.* 23 August 2018, <https://doi.org/10.3389/fрма.2018.00023>

⁶ <http://crossref.org>

⁷ <https://www.ncbi.nlm.nih.gov/pubmed/>

⁸ <https://orcid.org/content/download-file>

⁹ <https://orcid.org/organizations/integrators/API>

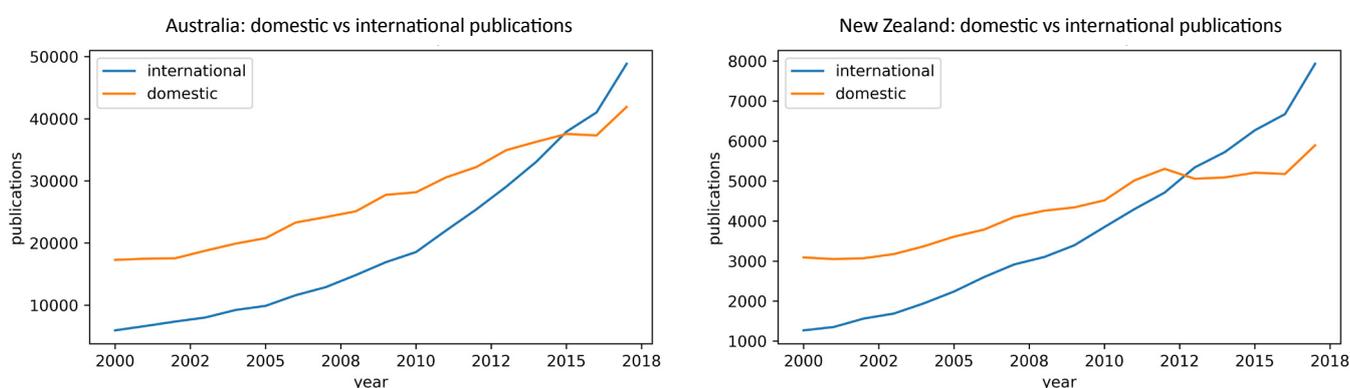
¹⁰ <http://grid.ac>

¹¹ <https://www.natureindex.com/faq#journals>

Collaboration on an International Scale

As Adams found, international collaboration has increased with time – both in Australia and New Zealand we find that the proportion of papers produced with at least one international author has risen significantly in the last decade. Figure 1 shows the international collaboration trend for both Australia and New Zealand since the turn of the new millennium. Note that in both countries, international research has been the prevalent mode for at least the last three years and shows continued strength. In an analysis of international-domestic publication trends by Field of Research code, it is worth noting that no particular Field of Research showed any trend to push international collaboration particularly faster than any other.

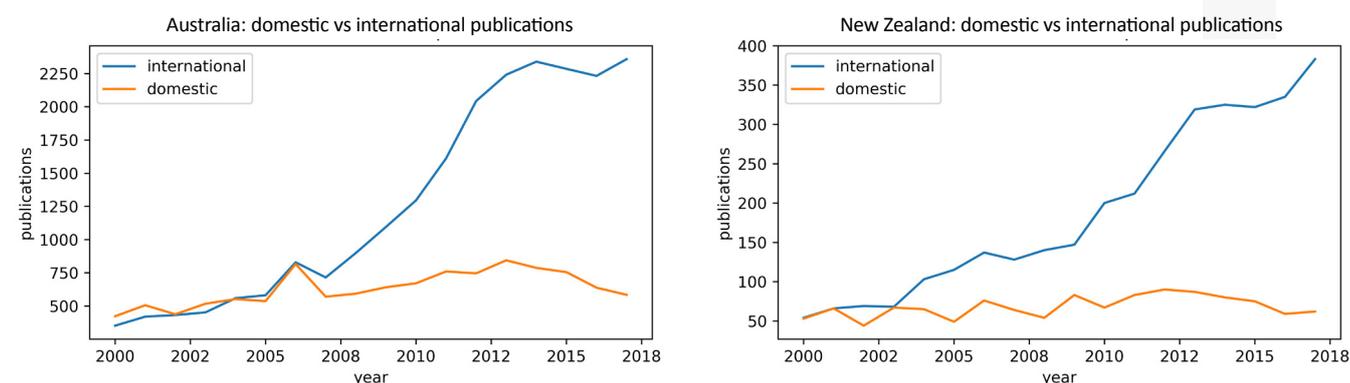
Figure 1: Journal article production for Australia (left) and New Zealand (right) between 2000 and 2018. The blue line shows internationally collaborative papers and the orange line shows papers that include only domestic authors. Both graphs include all Dimensions journal articles. Australian international research exceeds domestic research in 2015; New Zealand international research exceeds domestic research in 2012.



It is interesting to question the underlying drivers of the trends shown in Fig. 1: Are these trends due to high-quality research only (i.e. researchers with funding to more easily support international collaboration) or is this a universal feature of research in these countries? Are the trends mainly to collaborate across borders between Australia and New Zealand (due to geographic proximity)? Are the trends supported by particular subject biases?

To test the first supposition, we have recreated Fig.1. but limited it to the Nature Index journals list in Fig. 2. From these two graphs and the earlier crossing of the international and domestic trend lines compared with Fig.1, we can see that research published in high-quality journals was more internationally collaborative earlier. While international collaboration is clearly highly desirable it is (perhaps, unsurprisingly) researchers publishing in high-impact journals who have been able to pursue international collaboration ahead of the field in general. More recently, international collaboration trends are becoming more normal across a broader body of research.

Figure 2: Journal article production for Australia (left) and New Zealand (right) between 2000 and 2018. The blue line shows internationally collaborative papers and the orange line shows papers that include only domestic authors. Both graphs include only the Nature Journal List filter of Dimensions journal articles. Australian international research exceeds domestic research around 2004; New Zealand international research exceeds domestic research in 2001.



Both Australia and New Zealand have increased their share of not only internationally collaborative research but have both used this increase as a key driver to increase their actual share of global research.

In addition to the impressive increases in international collaboration shown in Fig.1. and Fig.2. both Australia and New Zealand have increased their share of not only internationally collaborative research but have both used this increase as a key driver to increase their actual share of global research. In the period between 2000 and 2018 Australia moved from around 2% of global research output to just over 3%, while New Zealand moved from 0.2% to 0.3% (based on the full Dimensions data rather than the Nature Index filtered data). Over the same time period, Australia moved from being a collaborative partner on around 6% of journal articles to around 10%, and New Zealand moved from around 1% to around 2%. Over the same period the US declined in global share (from 19% to 17%) and also in collaborative global share (from 43% to 38%) as China rapidly increased both its level of output and its level of international collaboration.

Looking further at collaboration by country, figure 3 demonstrates that both Australia and New Zealand are still heavily dependent on collaborations with the major research economies: the UK and the US. However, the growth of Chinese influence in Australia in particular is clear, surpassing UK collaborations in Australia during 2017. In New Zealand collaboration is still dominated by United States, Australia and The United Kingdom.

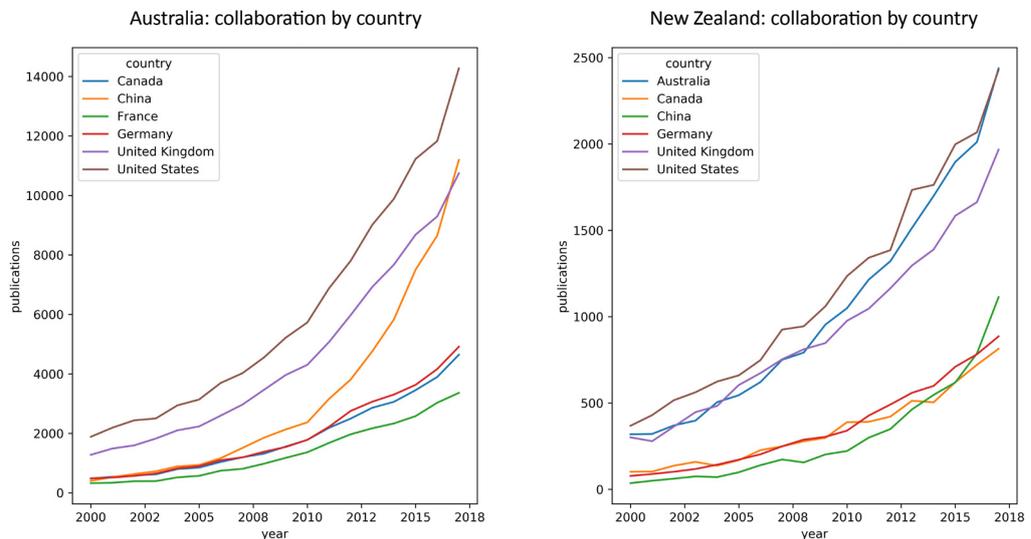


Figure 3: Countries by Journal article collaboration Australia (left) and New Zealand (right) between 2000 and 2018 Dimensions Dataset

Collaboration Between Australia and New Zealand

The relationship between Australia and New Zealand has always been close. However, this is not necessarily reflected as an equal partnership in cross-board research. A quick analysis, shown in Fig.4, of collaborations between institutions within Australasia reveals that, as a proportion of research the Universities of Auckland and Otago are, by far, the biggest actors in these collaborations and their partnerships are dominated by Group of Eight institutions.

Within the Nature Index Journals however, the relationship between Australia and New Zealand is less pronounced. As figure 5 illustrates, Australian collaboration with other non-Chinese partners including New Zealand has plateaued. For New Zealand, collaboration with Europe and the United States continues to increase independently of Australia, and collaboration with China is not yet a significant feature.

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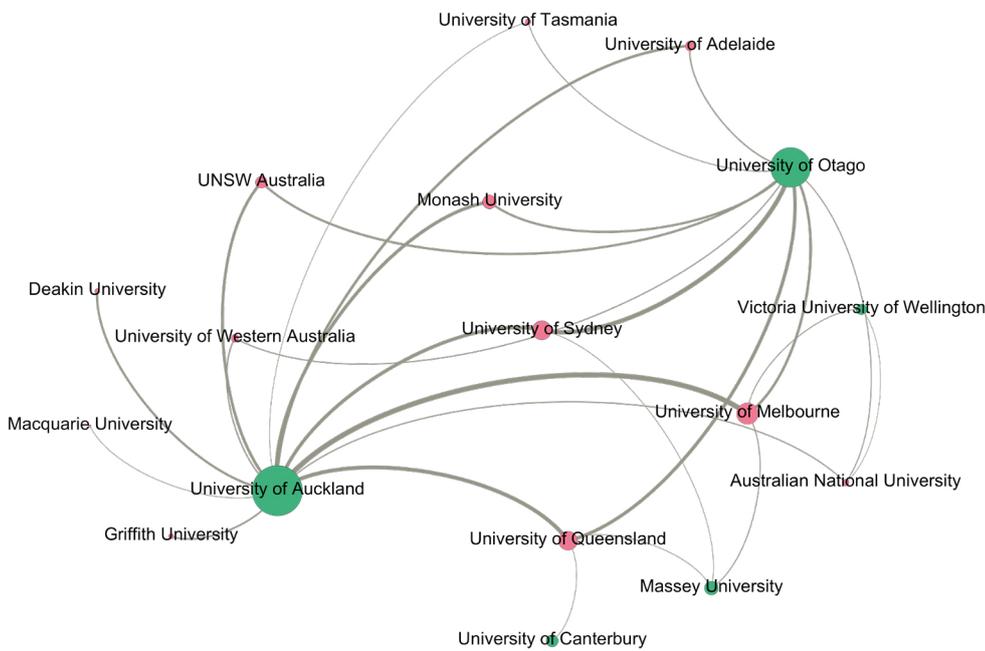


Figure 4: Collaborations by institution within the Australasian region.

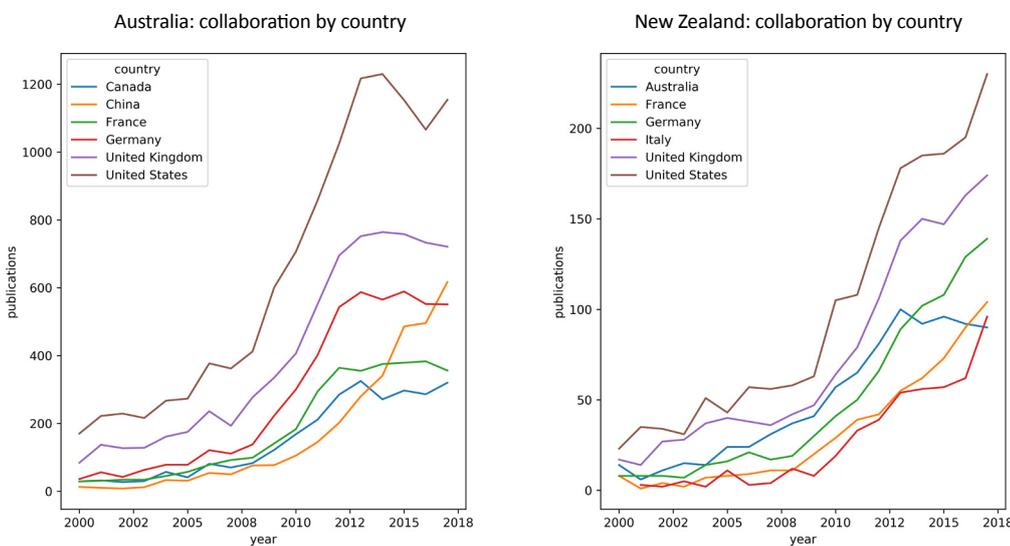


Figure 5: Countries by Journal article collaboration Australia (left) and New Zealand (right) between 2000 and 2018. Nature Index Journal List

Discussion

International collaboration is clearly on the rise and can be measured using publications databases. It is clear that academics publishing in high-impact journals are leading this revolution and that Australasian institutions have been amongst the early adopters and hence beneficiaries of this trend. Internationalism in research is generally seen as a positive thing since research problems are getting harder and require more resources to make progress. However, internationalism can also leave a research base open to the influence of other countries priorities and drivers. Some countries favour a blue-skies approach to research while others tend to prefer an applied approach. While some countries will naturally not collaborate due to these differences in the style of their research economies, resource scarcity often brings unlikely partners together. Diversity of research approaches and programmes is generally taken to be good for research. However, the dominance of China in the pacific region as a rising research power challenges this diversity in the same way that the US's view of research has influenced other research systems around the world in the 20th Century. It will be critical to continue to analyse these trends in order to assert the most appropriate research strategy for the region.

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